Mirror, mirror: fairness and justice in climate geoengineering

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I hereby declare that this thesis constitutes my own work (with the exception of Paper 3 which includes contributions from colleagues in the IAGP project, documented in Annex 1).

I further declare that the work included here has not been submitted for a degree elsewhere, and is unpublished (with the exception of the clearly marked papers included in Chapter 3).

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Abstract

Climate geoengineering seems an increasingly likely prospect as the gap between current mitigation action and that needed to avoid dangerous climate change remains substantial. Climate change raises fundamental questions of justice with respect to future generations, the poor and vulnerable in the contemporary world, and its relationship with processes of historically uneven development. The implications of geoengineering for prospects of justice in climate policy and politics are therefore critical.

This thesis examines ways in which geoengineering might contribute to or undermine climate justice. It illustrates the co-productive, indeterminate, and inherently moral nature of technologies such as those proposed for geoengineering. It particularly highlights interactions between proposals for geoengineering and the politics and practice of climate mitigation and climate risk management, and explores some of the implications of different conceptions of fairness and justice and of different social and political imaginaries. The thesis locates this exploration of justice concerns in a case for a relational care-based imaginary of the future, rather than in (neo)liberal administrative, risk-managerial imaginaries based on autonomous subjects. It also defends a plural approach to justice rooted in environmental justice scholarship, arguing for the consistent inclusion of understandings of restorative and corrective justice alongside distributional, procedural and recognitional justice.

The body of the thesis consists of five papers. Paper 1 locates the threat (and moral concern) of mitigation being deterred by climate engineering in a common but problematic definition of climate change as an issue of 'climate risk' rather than one of climate justice. Paper 2 suggests that even though climate engineering modellers sometimes broaden the understanding of the goals of climate policy to questions of distribution they tend to deploy a risk-analysis imaginary which imposes culturally, politically and ideologically narrow constructions of justice on the debate. Paper 3 finds that, in contrast, deliberative publics draw on a much broader set of justice concepts with regard to the uncertainties of climate change and geoengineering (including the prospects of mitigation deterrence). Paper 4 explores ways in which discourses of climate geoengineering are rooted in an administrative, risk-management social imaginary and support the maintenance of (neo)liberal capitalist economies through 'post-political' framings that increase the risk of mitigation deterrence. Paper 5 offers some alternative imaginaries through an examination of ethics of repair in potentially analogous arenas with relevant experience and debate. It illustrates how ethics of care, integrity and legibility, and the integration of restorative justice, would radically reframe ways of thinking about or practicing geoengineering.

To indicate a pathway towards such a reconfiguration of imaginaries, the thesis proposes a new synthesis of approaches to justice as recognition that develops and further politicizes the account applied in environmental justice scholarship, transforming political subjectivity. In turn this underpins a conclusion that climate geoengineering, as currently proposed and framed, is inherently unjust and unfair, primarily because of the ways in which it could be expected to act to sustain neo-liberal administrative imaginaries and politics. In the worst case many existing injustices would be maintained and exacerbated, while the risk of actually catastrophic climate change increased.

Contents

Commonly used abbreviations

ANT – Actor Network Theory

BECCS - Bioenergy with Carbon Capture and Storage

CCS – Carbon Capture and Storage

CDR - Carbon Dioxide Removal (synonymous with *Carbon Geoengineering)*

CGE - Climate Geoengineering

IPCC – Intergovernmental Panel on Climate Change

SAI - Stratospheric Aerosol Injection

STS - Science and Technology Studies

SRM - Solar Radiation Management (synonymous with *Solar Geoengineering*)

UNFCCC – United Nations Framework Convention on Climate Change

Acknowledgements and motivations

After the failure of the Copenhagen meeting of the UN Climate Convention in 2009 it seemed to me to be inevitable that conventional debates over the appropriate policies to mitigate and adapt to climate change would be increasingly supplemented by debate over so-called 'climate engineering' or 'geoengineering' responses. My cursory initial understanding of such approaches led me to be concerned that they could have as severe consequences for equality and justice as climate change itself and other responses proposed to it. Thus was born this research topic: seeking to understand the implications for justice of prospective climate engineering. The central challenge was seeking to understand whether - and under what conditions - some form of climate geoengineering might offer a fair and just response to climate change.

In engaging with this topic over the last six years, I have received support, advice and assistance from many quarters. Contrary to popular imaginaries of the lone researcher, a PhD is always a collaborative effort. I therefore have many people to thank. First and foremost my supervisors: Gordon Walker and Nils Markusson for their unstinting support, challenging critique and thoughtful guidance; and also Nigel Clark and John Childs for their constructive feedback as appraisers and reviewers of my progress. Even though I have spent far too little time physically in Lancaster, I have nonetheless benefited greatly from opportunities to draw on the advice and wisdom of other past and present staff and students, notably Andy Jarvis, Becky Willis, Bron Szerszynski, Maia Galarraga, Elizabeth Shove, David Tyfield, Noel Cass, John O'Neill, Andrew Sayer and Brian Wynne.

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[1] Online at https://www.ipsos.com/ipsos-mori/en-uk/experiment-earth

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[2] Online at: https://www.theguardian.com/science/political-science/2015/mar/14/wheres-the-justice-in-geoengineering

My involvement with issues of environmental justice goes back much further than my engagement with climate geoengineering. In particular I must acknowledge the opportunities I had working for Friends of the Earth (in both London and Edinburgh) to meet local and international environmental justice activists. Chances to learn from Eurig Scandrett, Tara O'Leary, Kevin Dunion, Clare Symonds, Nnimmo Bassey, Bobby Peek, Meena Raman, Cam Walker and Asad Rehman, amongst many others, were invaluable and kept my emerging understandings grounded in real cases. I must also thank Julian Agyeman, Bob Evans, and Bob Bullard for the chance to contribute to their volume on Just Sustainabilities way back in 2003. More recently I have benefited from chances to participate in environmental justice symposia in Norwich (2015) and Fort Collins (2017), and join in illuminating discussions with Saskia Vermeylen, Yogi Hendlin, Nicole Gross-Camp, Iokiñe Rodriguez, Janet Fisher, Leonie Bellina, James Fraser, David Schlosberg, Klara Stumpf, Brendan Coolsaet, Katie Powlen, Josh Sbicca, Christine Winter, Hannah Svarstad, Tor Benjaminson and many others. I also need to thank the environmental humanities groups at Linköping, KTH in Stockholm and at UNSW for the opportunities to engage with this emerging academic community, and particularly Cecilia Åsberg of the Seedbox, and Henrik Ernston. Dougald Hine, of Dark Mountain, also provided several helpful opportunities for me to explore themes and issues of my work with him in an environmental humanities setting.

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Chapter 1: Introduction

This thesis seeks to examine ways in which geoengineering might contribute to, or undermine climate justice. It considers this issue in the context of inevitable interactions between proposals for geoengineering and the politics and practice of climate mitigation and the ways in which these proposals reflect and reconstruct broader social imaginaries. It aims to identify and explain ways in which particular and plausible forms of climate geoengineering threaten to sustain profound climate related injustices through depoliticized discursive framings, narrow cultural conceptualizations of justice, and social and political imaginaries which mis-recognize disadvantaged groups in the past, present and future. This thesis consists of five papers with a *kappa* that introduces, interlinks, and develops the overall argument.[3] In this opening chapter of the kappa I briefly introduce the topic, set out the research questions and some key challenges arising from them, and discuss the methodologies adopted.

Climate geoengineering (CGE) is understood in this thesis as a group of large-scale primarily technological interventions in earth systems intended to limit or reverse the negative impacts of climate change (NAS 2015a&b, Keith 2013, Hulme 2014). Such interventions include those designed to mirror or reflect more sunlight from the earth, (normally termed SRM or solar radiation management, or 'solar geoengineering') and those designed to withdraw greenhouse gases from the climate system (normally termed CDR or carbon dioxide removal, or 'carbon geoengineering').

CGE appears an increasingly likely prospect as the gap between current mitigation action and that recommended by scientific analysis as necessary to avoid dangerous climate change remains substantial, with limited progress, at the time of writing again thrown into question by US politics. Climate change raises fundamental questions of justice with respect to future generations, the poor and vulnerable in the modern world, its relationship with processes of historically uneven development, and human relations to the natural world (as well as to our conceptions of virtue) (Athanasiou and Baer 2002, Hulme 2009, Malm 2016, Buck 2012a). The implications of geoengineering for prospects of justice in climate policy and politics are therefore of critical importance. The thesis attempts to make sense of these questions though application of environmental justice approaches, and in particular,

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[3] *Kappa* is the Swedish term for cape or coat, which is used as a technical term to describe the text that surrounds the published or submitted papers in a thesis like this. In the absence of a direct English equivalent, I have adopted it here.

through an exploration of the ways in which a richer and more political account of justice as recognition can underpin other dimensions of justice: distributive, procedural and especially restorative.

However, assessing the justice implications of CGE is not simply a matter of establishing the expected consequences of a geoengineering intervention and evaluating them against a relevant universal ideal of justice. Technologies (at least those of such global scale) co-produce futures, and co-produce social imaginaries and their cultures, politics and conceptions of justice (Groves 2014, Verbeek 2011). In this thesis I therefore seek to elaborate the co-productive, indeterminate, and yet inherently moral nature of technologies such as those proposed for CGE; identify interactions between proposals for CGE, and the politics and practice of climate mitigation and climate risk management; and explore some implications for society's relationship with CGE of different conceptions of fairness and justice and of different social and political imaginaries.

The thesis locates this exploration of justice concerns in arguments for the development of alternative social imaginaries, in particular, ones based in a relational understanding of care for the future (Groves 2014), in contrast with the contemporary dominant (neo)liberal administrative, risk-managerial imaginaries based on autonomous subjects. It also defends a plural approach to justice rooted in environmental justice scholarship (Schlosberg 2007, Walker 2012), arguing not only for the consistent inclusion of understandings of restorative and corrective justice alongside distributional and procedural justice, but also for a richer and more political account of recognition both as a foundation for these claims, and as a fundamental means by which social imaginaries might be reconfigured or transformed. In conclusion I suggest that without such a reconfiguration of our understandings of justice, the ways in which CGE can act to sustain (neo)liberal administrative imaginaries and politics will maintain and exacerbate injustice, while increasing the risk of actually catastrophic climate change, arguably making CGE a 'false solution.'

Over the last five to six years climate geoengineering has evolved as an object of research and of policy, and I have interrogated it from diverse directions and perspectives. Notably, my research has also been located in the emerging literature of the Anthropocene: the self-proclaimed geological age of humans. I use the term not so much as an objective scientific category, but as a setting and part of a discursive debate, deployed critically to help characterize and deconstruct framings. The term nonetheless implies a significant qualitative change in the circumstances of human life on earth, which I argue, also has relevance for the ways in which humans might and, arguably, should conceptualize justice.

In the remainder of *Chapter 1* I explain how I now perceive and understand climate engineering as a topic; and explore some of the methodological challenges raised by the combination of a mutable and evolving subject with a set of emerging and reflexive conceptual perspectives.

Chapter 2 outlines key concepts in both CGE and justice, and introduces four fundamental theoretical and disciplinary foundations (social imaginaries, co-produced 'moral' technologies, plural justice and conditioned political agency) providing the necessary conceptual and methodological contextualization for what follows.

Chapter 3 presents the five papers, each with a brief introduction.

Chapter 4 provides a synthesis and discussion of the justice issues and concepts exposed in the five papers, in the light of the foundations provided in Chapter 3 – in particular highlighting interaction effects that suggest a likelihood of mitigation deterrence; framing effects that reduce the likelihood of consideration of CGE from plural perspectives on justice; and approaches to risk and vulnerability that permit continuing misrecognition of actual and likely victims of climate change.

Chapter 5 then elaborates a case for a richer political account of recognition, explaining both how lack of recognition is endemic in CGE discourses today, and how a political understanding of recognition reveals its potential as a transformative force to reconfigure the dominant social imaginary.

Chapter 6 draws conclusions, and suggests some potential applications and next steps.

The detail of this ordering perhaps merits further explanation. I intentionally delay further introducing and defining the topic of 'climate geoengineering' because I wish to avoid reifying it as a determinate object that is – in some Platonic way – apprehended only dimly through these different perspectives. Instead I seek to acknowledge the ways in which the topic is itself co-constructed by observers, their perspectives, methodologies and epistemologies. In other words, CGE is not simply a technical object, which might be defined by science or engineering, but a social object, and even a social subject that in turn *acts on* society. Of course, justice is equally plural, fluid and co-constituting, and also demands reflective and reflexive consideration. Analytical academic philosophers make similar errors to scientists and engineers, reifying concepts such as justice, so in the process of research and writing of this thesis, I have sought to be alert both to the fluidity of concepts, and to the pressures for (and implications of) freezing them.

1.1 The research question(s)

Given the fluidity of the concepts involved, it would have been foolish to expect the initial research questions to remain unaltered throughout. And indeed my understanding of my questions has co-evolved with my understanding of potential answers.

At its core however, the central question has always been:

> '*How might CGE contribute to or undermine justice in the context of climate change*?'

This question encompasses not only consideration of the potential consequences of CGE (as a result of ameliorating or reconfiguring the impacts of climate change), but also any ways in which it reshapes expectations and imaginaries, notably considering ways in which discussion of CGE might 'frame-out' considerations of (or particular approaches to) justice. Thus the research also asked:

> '*How do current discourses (and the social imaginaries underlying them) construct particular ideas of CGE technologies and conceptions of justice*?'

In particular this demanded interrogation of the ideas of mitigation deterrence and the moral hazard (*Paper 1*).

A third question emerged in the conduct of the research and in consideration of the interactions between CGE imaginaries and conceptions of justice:

> '*To what extent are the problems here a product of misrecognition, and can recognition help reconfigure discourses and imaginaries so they support climate justice*?'

For this question to emerge required acknowledgement of the possibility of plural conceptions and dimensions of justice not widely considered in modern society.

In wrestling with these questions throughout the PhD, my understanding of both CGE and (climate) justice evolved. The concepts are considered in more depth later. At this point, suffice to note that CGE is understood here primarily as a socio-technical imaginary (Jasanoff 2015) rather than an objective material technology. And that justice is also understood primarily as a social construct (part of a broader social imaginary), co-produced in affect and action (Sayer 2011, Schlosberg 2007) rather than an objective truth rationally discovered by moral philosophy. This is not to argue entirely from a social constructivist position. Both technological science and moral philosophy have much to tell us about their respective domains, yet their disciplinary practices, epistemologies and ontologies also contribute

directly to processes in which socio-technical systems and social imaginaries are co-produced.

In the same spirit, climate change is seen not principally as a technical problem, but as "an environmental, cultural and political phenomenon that is reshaping the way we think about ourselves, about our societies and about humanity's place on Earth" (Hulme, 2009: 1). In particular it is approached here as an issue of justice, following a rich literature on *climate justice* which highlights the extent to which the impacts of climate change are disproportionately imposed on the poor, powerless and those who have contributed least to the problem (see for example Athanasiou and Baer 2002, Baer et al 2008, Gardiner 2011a). Yet Hulme's challenge to us to reinterpret humanity's relationships suggests a need to go beyond such typically consequentialist approaches to justice, and also develop and adopt new or restored virtues in line with the circumstances of the planet and the age.

It is not clear to me, however, that such a perspective necessarily leads one to reject CGE, or to consider it unjust. Rather, ethical and technical judgments are culturally and politically entangled, in settings riddled with uncertainty and even indeterminacy. I argue here that they therefore demand plural, iterative and deeply reflexive approaches, which are both normative and critical in motivation.[4] To help the reader appreciate this response, I now briefly elaborate how CGE *might* be understood as just, and outline how I have interrogated that case, and its situated conditions.

The development of the research in context

Within the contemporary liberal social imaginary, and materialist scientific understanding of climate change, there are coherent arguments that CGE in both forms could contribute to justice: in the case of CDR, by 'shaving the peak' off atmospheric concentrations of greenhouse gases, and accelerating their decline, thus reducing impacts and risks for future people; and in the case of SRM, by 'shaving the peak' off temperature, and accelerating its return toward pre-industrial levels; thus reducing impacts and risks for current and near future people. In both cases it is arguable that the benefits will be progressively distributed, insofar as those benefiting most from reduced impacts and risks would be the poor and vulnerable.[5] In both cases the (apparent) need for CGE technologies follows specific but rational assumptions about the levels of inertia in the climate system (meaning that already

[4] Of course, this does not preclude arriving at a normative judgment that rules out CGE.

[5] Argument based on Horton and Keith 2016, but extended by parallel to CDR.

accumulated emissions commit humanity to more warming than has yet occurred) and in the political and economic systems (where inertia commits humanity to more emissions).

Horton and Keith (2016) set out a case along these lines for justice in solar geoengineering, but the underlying arguments and assumptions have been circulating in the world of CGE conferences, summer schools and other events for several years. In participating in such events I was early intrigued to perceive the ethical convictions with which CGE research is advocated by many of the scientists involved. I came to realize that this primarily reflected growing conviction of the implausibility of more conventional responses, especially as continued delays in mitigation led to demands for ever more rapid and radical programs to keep within the generally accepted limits of climate safety (as suggested by the IPCC). In other words a perception of CGE research as an ethical duty appeared to follow from a judgment that the inertia of the system is high. Such scientists almost universally treat CGE as a supplement to mitigation. However we cannot assume that this would be true of actual decision-makers in practice, when policy decisions reflect political, social and economic interests more than scientific judgment.

Judgments of capacity are critical to such ethical and practical assessment: if humanity can, acting collectively, avert dangerous climate change by accelerated mitigation, CDR and adaptation, CGE researchers appear to treat this as a preferable, and more ethical option. But if one judges that economic and climate inertia makes such an approach implausible, then considering (or even pursuing) SRM becomes not just reasonable, but potentially an ethical duty. It appears that many CGE researchers – like Horton and Keith (2016) - think we are already past this point. At this point, my aim is not to argue one way or the other, but to demonstrate that our understanding of the ethics of SRM, and of our duties and aims in researching it, might change dramatically depending on a relatively small change in context. Indeed, in the face of climate unknowns and uncertainties, exactly the same physical and economic parameters could mean that non-SRM routes to climate safety are simultaneously both plausible and implausible. In other words we may live in a state of both practical and ethical indeterminacy. If so we cannot establish the ethically right path simply on the basis of consequences, nor assess it simply in an empirical manner.

Arguments such as those of Horton and Keith are not the only engagements between CGE research and justice issues. A significant element of the modeling literature has sought to predict distributional implications in some ways (see *Paper 2*). Moreover there is a rich literature on the ethics of CGE often addressing justice concerns (e.g. Gardiner 2011b, Preston 2012 & 2013, Hamilton 2013, Morrow 2014a&b, Svoboda et al 2011, Svoboda

2016). There is also a growing literature which treats CGE as a socio-technical system (e.g. Nehrlich and Jaspal 2012, Cairns and Stirling 2014, Bellamy and Lezaun 2015). But there is very little overlap. And it is in this shortfall that I hope this thesis enriches understanding, by exploring justice implications in the evolution of co-constructed social and socio-technical imaginaries. As discussed in the next chapter, this raises some methodological issues: not least the validity of applying a normative approach to justice in a constructivist setting regarding the nature of technology.

In coming to an understanding of the implications of CGE for climate justice through researching and writing the papers at the core of the thesis I explored the ways geo-engineering was being positioned and framed (*Papers 1, 2* and *4*), the conceptions of justice that might be appropriately applied to geoengineering and its implications (*Papers 3* and *5*), the ways geo-engineering resembles or differs from other responses to climate change in its discursive characteristics and justice implications (*Papers 1* and *4*) and the relative justice implications of different types of geo-engineering technology (*Paper 4* and McLaren 2012a). I do not elaborate on each of these specific lines of inquiry further, but offer them here as an indication of the directions that structured my engagement with the topic.

Over the course of my research, the emphasis has shifted reflexively. Having begun with an aspiration to find and rationally and empirically analyze justice issues (against some preexisting abstract ideal or ideals), the process evolved to one of challenging and reconfiguring questions of justice to better engage – both intellectually and normatively – with emerging demands for CGE in a discursive Anthropocene. As a consequence, across the thesis I trace through some of the ways in which exploration of CGE is (and should be) reframing and reconfiguring ideas of justice, with particular reference to possible and plausible interactions between CGE and climate mitigation. One such interaction is often termed the moral hazard problem, but can be more neutrally described as mitigation deterrence (processes through which the consideration or development of CGE responses deter, delay or substitute for accelerated action on mitigation).

In the face of deep uncertainties – or even indeterminacy - about ongoing GHG emissions, climate responses and technological developments it might seem entirely rational to argue for (at least) enhanced research into CGE. I agree that there is a case for research, but argue through the five papers that the unreflexive adoption of this case in the academic, political and business worlds would be likely to generate potentially significant levels of mitigation deterrence (see particularly *Papers 1* and *4*). The mechanisms involved arise through the ways in which the emerging socio-technical systems of CGE technologies are located in

particular social imaginaries and associated political economies, which *inter alia* frame out alternative conceptions of justice (*Papers 2* and *4*). *Paper 4* argues that there is a particular reason for normative concern with respect to mitigation deterrence insofar as mitigation is embedded in political and social debate around climate justice, while CGE and arguments for it (even those which reference justice concerns) are primarily embedded in a depoliticized, technical, and administrative risk management debate which largely ignores differential vulnerability and the demands for greater solidarity which arise from a historical analysis of the reasons for risk and vulnerability (Malm 2016, Athanasiou and Baer 2002). Thus in some ways, justice is 'framed out' from CGE discourses, and in others, is limited to particular situated forms compatible with the dominant socio-technological imaginaries and political economies. *Papers 2* and *3* apply different methodological approaches to surface and expose the specific and situated conceptions of justice involved. In different ways, the framing out exposed is both a result of, and a cause of, misrecognition of groups, values and epistemologies. *Paper 5* begins the task of decentering the dominant concepts and imaginaries and reconfiguring ethics and justice for an understanding of the Anthropocene in which humanity is powerful, but also deeply divided and unequal. Chapter 5 of this kappa paper seeks to develop and extend this analysis, in a more detailed exploration of a political account of recognition, and its consequences for CGE.

There is a central tension running through this thesis between the process of evaluating CGE and its implications against some concept of justice; and the activity of understanding how it might reconfigure our concepts of justice. In practice this has been resolved as a side-effect of my taking an ontologically and methodologically plural approach to justice which identifies pragmatic ethics in behavior and deliberation, as well as applying philosophical reasoning. The tension is also one between normative and analytic foundations. In common with environmental justice and most other critical scholarship my work is located in a normative quest for greater justice. Yet it is also critically analytic of the roles CGE plays in co-constructing the contemporary world and our understandings of its past and futures. I do not see this as a tension between incompatible opposites, but one that can be constructive and generative in both theoretical and practical realms. For example, an evaluative (normative) approach helps us see where and why CGE might be contested in practice – regardless of our apparent inability definitively to determine its normative status, nor evaluate its (relative) justice implications (in the face of co-constructed and mutable concepts of justice). In turn this opens the prospect of pursuing or resisting it in ways that better reflect, re-articulate and embody justice concerns.

In summary therefore, my engagement with my research questions has been reflexive, iterative, plural, critical and normative. Next I outline the methodological approaches I have applied and discuss some of the issues arising.

1.2 Methodological approaches

This study spans a diverse interdisciplinary space, from ethics to engineering, and more. It has inevitably therefore involved diverse methodologies. This section outlines a pragmatic and coherentist ethics that I have deployed in the project as a whole, as a means of implementing reflexivity and plurality in a simultaneously critical and normative stance. It then discusses some of the challenges of combining diverse methodological approaches, and of working in diverse discursive registers. It then summarizes the methods involved in each of the five papers as ways of engaging with the research questions. It subsequently turns to the informal participant observation and experimental interactions involved, before concluding with a discussion of the challenges of drawing normative conclusions in a (partially) constructivist setting.

Coherentist and Pragmatic

Overall I have sought to combine a pragmatic approach to the discovery of emergent ethics or virtues in observation and practice (Minteer and Manning 1999, Minteer 2011); a coherentist philosophical logic (Quine 1951, Lehrer 1997); deliberative public engagement (Pidgeon and Henwood 2004, Capstick et al 2015); participant observation (DeWalt et al 1998); and critical discourse analysis (Fairclough 1995, Blommaert and Bulcaen 2000). In discourse terms I have engaged not only with academic texts, but also with public statements and media coverage (as represented particularly in paper 4's 'meta-analysis' of climate and CGE discourse. Taken together these permit engagement with all three research questions, helping us first understand how the technologies and justice conceptions are co-produced in discourse; then evaluate the justness of the socio-technical systems and their impacts; and finally identify the ways in which mis-recognition contributes to the injustices found.

Coherentist philosophy seeks to find practical wisdom in shared, overlapping, and thus 'coherent' philosophical conclusions and approaches (as opposed to those which seek to highlight contrasts with one another in an – often counter-productive - effort to approach a single universal truth). In the pursuit of a coherent ethical base, I have sought ethical stances that fit together and cast light on the observed behaviors and discourses, regardless of their

source, thus blending aspects of virtue, deontological and even consequentialist ethics, sources and inspirations.

In blending philosophical approaches I have particularly drawn on Sen (2009), Sayer (2011) and Held (2006). First, Sen's approach to capabilities and freedom in an imperfect (or non-ideal) world provides an invaluable pragmatic base for identifying greater (or lesser) justice in the free exercise of choices and capacities for people to live the lives in which they find value, supported by collective institutions and communities. Second, my approach also reflects Sayer's (2011) understanding of both the importance of the inherent affective processes which make humans evaluative beings (able to find greater or lesser value in particular lives and arrangements of society); and of the ways in which these processes function regardless of apparent philosophical contradictions. In other words, humans do not rely on detailed philosophical and logical consistency in their values, for those values to motivate and mobilize action. As I discuss at greater length in Foundation 3 below, such a view also relies on a meaningful conception of agency. And third, Held's approach to the ethics of care, finding a basis for moral duties in the fundamental practical significance of inter-personal relationships of care in the development of human lives and sensibilities, and applied more broadly to individual and collective human relationships in political activities and institutions, also strongly influences the ethical perspective expressed here.

Pluralist

My approach is coherent in another sense: it rejects the theoretical monologism of metropolitan social science (Connell 2007) in favor of pluralism, in a way that is consistent and coherent with the mechanics of recognition as an approach to epistemic justice (respecting diversity and difference, rather than seeking integration into or replacement of dominant approaches).

Although all of the methods applied are qualitative in nature the combination of diverse approaches offers similar benefits (and raises similar challenges) to the use of mixed quantitative and qualitative methods in social science. Combining methodologies enables some triangulation, exposes different framings, reveals emergent findings and offers opportunity for better insights into complex or contradictory phenomena (Creswell 2011, Fiorini et al 2016). The complexities in this case are exacerbated by the need to engage with contested concepts and framings; in spaces where relevant actors are subject to disciplinary and cognitive biases. The combination of different methods offers important opportunities to circumvent or expose such biases (See paper 2 for example). Mixed methods typically

raise challenges regarding the generalizability of findings and the practical combination of different data. In the present case generalizability is not a major concern, as the research does not seek to extrapolate findings from a sub-set of a larger population, but addresses both the breadth and depth of the CGE issue space, while the practical issues raised by different qualitative approaches are less challenging than for merging qualitative and quantitative data. Perhaps the most serious concern at first sight is that of epistemological inconsistency, which might be thought to generate incompatible data or findings (Cojocaru 2010). However, the practical implementation of mixed methods is pragmatic in orientation, and can reduce conflicts between constructivist and positivist interpretations (Cojocaru 2010). Combining methodologies puts underlying epistemologies into dialogue with each other – a challenging but rewarding process which reveals intersections and commonalities as much as contradictions (see *Papers 2* and *5*).

With a focus for research like CGE, where the space is dominated by both technological and social imaginaries, it is essential to go beyond a single dimension of empirical evidence, such as that provided by deliberative engagement, to also examine the discursive level, and to interrogate the philosophical and ethical underpinnings of what Inayatullah (2004, 2008) calls the 'archetypal layer' and others describe as the underlying social imaginary (Taylor 2003, Groves 2014).

Inayatullah (2008) distinguishes four layers in constructing, and deconstructing predictions and scenarios of the future – although such layers equally apply to efforts to understand the present and past. The term 'layer' perhaps suggests too formal a structure and hierarchy. But distinguishing the 'litany' (existing trends, and treatments in popular discourse); the 'systemic' (analysis of economic, social, political and historic causes - often found in policy level treatments – or reached by deliberative engagement); the 'discursive' (worldviews, narratives and frames which mediate, legitimate or even constitute the issue at hand, bringing questions of power, ideology and epistemology center stage); and the 'archetypal' (the culturally varied myths and metaphors that underpin discourse) is helpful. Each of these discursive registers is amenable to a variety of methodological approaches, some more illuminating than others, while the structure suggests a framework within which findings can be usefully combined.

All aspects of this complex discursive space are co-constructed in the development of new technologies (see Section 2.4). Once it becomes clear that that research itself in this space (including the present thesis) acts to co-construct relevant imaginaries, it seems obvious that an iterative process is required to examine reflexively the potential impact of the research,

and to ensure an ethical stance with respect to any normative conclusions drawn. If the research has such impacts on imaginaries, then these must be part of any normative assessment, and as researchers we would appear obligated to ask whether the research contributes to a just form of social imaginary, or an unjust one. As I argue in more detail later (in Chapter 4), through its presuppositions much of the CGE literature sustains an existing unjust social imaginary, and the researchers involved generally fail to be reflexive about this, or their role in it. This concern (regarding effects on social imaginaries) is a more general expression of the problem of moral hazard: that by researching CGE we may unintentionally encourage decision makers to reduce or delay commitments to climate mitigation. This risk has been high in my mind throughout the research, and has strongly influenced both my methodological stance of trying to surface presuppositions, and my communication of the topic (see *Paper 1* in particular).

Iterative and reflexive

The combination of methodologies from different philosophical and disciplinary traditions enabled me to conduct an iterative exploration of the research questions across the different layers indicated by Inayatullah.

In practice, this iterative approach involved eliciting and comparing different considerations and approaches to justice – from justice theory (especially as developed by environmental justice scholars (see Section 2.6)), from public engagement (*Paper 3*) and discursive analysis (*Paper 4*), and from socio-technical reviews of geoengineering options (McLaren 2012a and *Paper 2*) – as a means to surface and investigate the justice implications that are arising as CGE technologies approach implementation, so as to develop better understanding of the politics and ethics of CGE in the context of the dominant social imaginary. Iteration was essential, as it is only in understanding how the dominant social imaginary structures and constructs both technologies and conceptions of justice that the full extent of the risks of framing out, and thus of mitigation deterrence, can begin to be apprehended. Moreover, iteration is necessitated by the relationships between the presuppositions and expectations of the social imaginaries in play and the artifacts of the empirical landscape (public opinions, modeling exercises, discursive narratives etc.). As the former are surfaced and exposed, they are simultaneously revealed by examination of the latter and reproduced by those same artifacts. So a reflexive process is essential, not only to apprehend the inherent dynamism, but also to permit any meaningful normative evaluation.

This iterative and reflexive approach extended to my adoption and development of the foundational theories and concepts applied in the thesis (and set out below in Chapter 2). These were not established *de novo* in advance of the study, but emerged through the ongoing research practice and writing of the papers. Taken together the foundations establish the lens through which I have perceived and sought to understand the topic as a whole. On the other hand, they do not consistently and explicitly appear in the five papers.

1.3 Methods

The specific methods used across my PhD research – and their potential benefits and shortcomings - are illustrated by the principal approaches applied (and briefly described) in the five papers: deliberative engagement; discourse analysis and pragmatic ethics.

Deliberative engagement

Paper 3 is based on deliberative public engagement, in the form of facilitated discussions with recruited heterogeneous groups of members of the public (in this case in several UK cities). At its best the process allows both opinions and underlying values on a topic to emerge, and in emerging technology cases like CGE it can be indicative of likely public reactions and motivations (Pidgeon and Rogers-Hayden 2007, Chilvers and Kearnes 2016). It can facilitate reflexivity in the research community too, especially where it reveals gaps and inconsistencies between public perceptions and those of researchers. Done well it treats such gaps not as a knowledge deficit to be filled, but as a generative space for new understanding. However, in cases like CGE, where the topic remains largely imaginary, such processes necessarily act to constitute a public. In this context, the framings used, however carefully designed and cautiously introduced, will shape the nature of that public (*Paper 3*, Chilvers and Kearnes 2016, Bellamy and Lezaun 2015), partly structuring the values, conceptions and imaginaries that emerge in the process. For instance, a simple decision to treat CGE as 'an emerging technology' or as a 'response to climate change' sets in train specific associations and framings. A blank sheet is impossible to establish. Co-constituting a public for CGE is not itself problematic, but carries real moral responsibilities. In particular if we accept that the moral hazard of CGE grows the more it is perceived as an alternative to mitigation (*Paper 1*), then it follows that the 'normalization' of CGE as a part of the climate discussion could alone stimulate moral hazard (especially of the political, vested interest form (Corner and Pidgeon 2014)). In this respect the deployment of deliberative engagement must be approached with care. *Paper 3* reports a secondary analysis of the transcripts of already completed deliberation, and by exploring and analyzing the

participants' responses with respect to mitigation deterrence, it is to be hoped that it reduces the moral hazard involved. Nonetheless researchers using deliberative engagement should be aware of the way in which the process contributes to the relational creation and reconfiguration of norms and ethics, especially in the ways it reproduces aspects and presumptions of the dominant social imaginary. Chilvers and Kearnes (2016) illustrate many ways in which the participatory turn in research fails to break out of the dominant imaginary (for example, treating publics as aggregations of autonomous individuals; technologizing participation; or applying a linear model of engagement) and thus acts to sustain technocratic and administrative power.

Discourse analysis

Papers 2 and *4* deploy critical discourse analysis at very different levels and scales. Critical Discourse Analysis (CDA) - seeks to produce insights into the way discourse reproduces (or resists) social and political inequality, power abuse or domination (Fairclough 1995). *Paper 2* uses a socio-technical lens to examine the discourses regarding and embedded in the use of climate models to attempt to anticipate the likely effects of CGE. *Paper 4* is based on a review of the several large studies conducted on CGE in media and public discourse, offering a 'meta-analysis' of themes and framings identified. By different means each reveals ways in which certain topics and perspectives are framed out, and other narratives and perspectives strengthened and reproduced (whether through cognitive or social mechanisms). In discursive contests dominant narratives still have to respond to critique – often by cooption or redefinition. Such comparative analysis of discourses, particularly dynamic ones, which seek to identify change over time as well as differences across disciplines, media or geographies, are helpful in revealing how such responses sustain or weaken dominant narratives (Anselm and Hansson 2014).

Discourse analysis presents several challenges as a tool for engaging with topics of justice, not least that published material reflects all sorts of constraints (from disciplinary conventions to media norms) which structure and constrain the ways in which such topics are covered (*Paper 4*). A structured dialogic or engagement approach therefore helpfully supplements discourse analysis. In this case, resources did not permit such an approach, while informal conversations with modelers suggest a lack of reflexivity about their values and presumptions; and a cognitive dissonance in discussing such topics. Both are understandable from the standpoint of the dominant social imaginary, which actively distances normative analysis from science; and eschews affective evaluation in favor of

technical and empirical approaches (Sayer 2011, Groves 2014). Again the consequence is an argument for thoughtful reflexivity in interpreting and using the results of such studies.

Pragmatic ethics

Papers 2 and *5* also put into practice an approach of pragmatic ethics, seeking to surface conceptions of justice from practice and discourse: respectively in CGE modeling (*Paper 2*) and through a critical reading of literatures reporting on practices of repair and restoration (and the ethical debates they trigger) in different disciplines (*Paper 5*). Again, on reflection, supplementing this approach with deliberative interviews with practitioners would have been desirable had time and resources permitted. In this way the emergent ethics visible in practice and discourse could have been tested against acknowledged values and motivations, allowing a richer exploration of the origins and significance of the ethical stances identified. Nonetheless the use of a pragmatic ethics framework is much more consistent with the epistemological and ontological foundations of co-produced social and technological imaginaries than seeking to impose a particular universal philosophical ethical framework.

Participant observation

My confidence in the interpretations I derive from these methodological approaches is not only a product of the triangulation of findings between the methods, but bolstered by my 'participant observation' in the CGE research community, at summer schools, conferences and other events throughout the last six years. Whilst lacking the discipline and intensity of a closely documented ethnographic study this engagement (and my notes of many of the meetings) provide greater confidence in the validity of the conclusions drawn from discourse analysis, public engagement and pragmatic ethical analysis. However I have to acknowledge that my 'embedded' status will have influenced my perceptions in various ways. CGE has certainly become a much more normalized part of my thinking and discourse, requiring careful reflection. But in contrast with the strict demands put on embedded war reporters with whom Stilgoe (2015) compares social science researchers in climate engineering, my ability to question the appropriateness of my setting would appear relatively unimpaired. In particular, the independence arising from a self-funded PhD position meant I didn't face much pressure or expectation from the technologists and natural scientists in the field to act as a facilitator or soothsayer (a general concern highlighted by Chilvers and Kearnes (2016) in their critique of 'professional facilitation' of public engagement). Nonetheless I acknowledge the risk that I might have succumbed to, and replicated the moral hazard

problem as a result: and that my conclusions set out in this document may also reflect a desire to resist such cooption into the discourse, and therefore exaggerate the moral hazard concern. That judgment I will have to leave to you as the reader.

All these methods, not only the last, might be usefully understood as examples of 'experimental interactions in social science: not neutral observation, but snapshots in a process of engagement and reflection' (Stilgoe 2015:14, citing Rabinow and Bennett). In other words there is no pretense here to a false empirical objectivity which only serves to privilege certain disciplines and discourses over others (as noted by Sayer, 2011), but rather a willingness to use different approaches in an iterative and experimental way.

1.4 Methodological reflections

Finally in this chapter I offer some reflections on methodological learning.

Constructivism or realism?

Working with ethics in a (partially) constructivist setting is not just an inter-disciplinary challenge, but one which bridges diverse epistemological (and even ontological) traditions. But, in part as a result of the dialogue of epistemologies generated by the application of diverse methods, I have come to find the idea of a realist: constructivist dualism unhelpful. Rather I now understand constructivism as a process in which aspects of reality (especially in the social, cultural, political and economic realms) are reconfigured (both conceptually, and physically), in turn providing a new setting in which the process repeats. This thesis is not the place to explore the limits to which aspects of observed experience can and cannot be reconfigured through the power of imagination. Suffice to note that in my view, some of the underlying physical and biological relationships critical for understanding climate and humanity are not susceptible to such reconfiguration (CO_2's capacity to trap heat in the atmosphere being one example; human genetic characteristics perhaps being another). On the other hand, society, economics and politics are in many respects independent of such physical rules and realities.

Along with this new perspective on social constructivism I have found my epistemological and ontological views shifting to a more relational view of both (Thayer-Bacon 2010, Benjamin 2015). In particular this reflects the view from the ethics of care (Held 2006) that the relationships between people are of principal moral importance and precede other moral formulations, and moreover, that human subjectivity is by necessity relational. My position might therefore be described as a semi- or re-constructivist critical realism. Here

the 'semi-constructivism' directly reflects a relational epistemology and ontology, insofar as it is the constitutive relationships between subjects and objects that can be observed and analyzed, and which in turn construct (within constraints and structures), the subjects and objects themselves as well as the relationships between them.[6]

One last methodological reflexion

Before leaving the question of methodology, there is one practical caveat I wish to explore briefly. The normative approach of the project – drawing on environmental justice scholarship – has highlighted the importance of recognition of difference. However much of the research was designed and conducted before the overall significance of recognition became clear. Thus it is unlikely that the practical deliberations of *Paper 3*, the discourse analysis of *Paper 4*, and even the ethical examination of modeling in *Paper 2* genuinely and fully recognize outsiders and their interests in the topic to hand. This is not only a matter of timing, but also one of the limitations of 'granted' forms of recognition in comparison with forms which are alternatively or also 'demanded' (see Section 5.4). Future studies may be better placed to value and meaningfully incorporate different perspectives and the meanings drawn from them by different actors. In a small way, *Paper 5* is not just a paradigm or imaginary-busting attempt, but also offers a template for efforts to incorporate such acts of recognition within research, and an indication of ways to further improve this, for example by study visits to explore the pragmatic ethics of repair in situ.

[6] This fusion or hybrid of social constructivism and critical realism in part relies on the idea of the social imaginary (see Section 4.3) and the potential for social imaginaries to be transformed.

Chapter 2: Conceptual Foundations and Definitions

This chapter moves on from methodologies to theory. It first briefly defines key concepts in both climate geoengineering, and in justice, enabling a better understanding of the scope of the PhD. It then draws on science and technology studies, sociology, moral philosophy and environmental justice theories about (and approaches to) technology, justice, and agency, contextualized by the concept of social imaginaries, to establish the theoretical foundations of the thesis. In this chapter I first outline how I use the concept of social imaginaries as an ontological framework that enables me to surface and interrogate the presuppositions that structure technological and justice discourses and the notions of power and agency they co-construct. I then outline a co-productionist approach to technology and justice which in turn problematizes questions of power, agency and subjectivity. Finally I elaborate the plural ways in which an understanding of social imaginaries, co-production and structured subjectivity mean we should conceive of justice. In each section I introduce the conceptual foundation I have adopted, and outline its relevance to the topic and approach of the thesis.

2.1 Defining climate geoengineering

Climate geoengineering (CGE) is here understood as a third possible category of societal response to climate change, in addition to mitigation and adaptation. It is therefore an emerging subfield of climate policy. It is not exclusively, but primarily a technological response to climate change: therefore meriting analysis situated in learning from other technological approaches to social and environmental challenges and from science and technology studies more broadly.

I use the terms climate engineering, geoengineering and climate geoengineering synonymously, and deliberately. This is not to deny the discursive politics of terminology and categorization: *Paper 5* notes active efforts by researchers and advocates to revise the terminology, indicating the contested politics involved. Acts of categorization and boundary demarcation are political acts of discursive framing (Fairclough 1995) and thus ones to which we should pay attention (amongst the various ways in which climate engineering might have implications for justice).

For example, the NAS committee (2015 a&b) made an effort to adopt the terminology of 'climate intervention'. This terminology might reasonably suggest a move away from the certainty of outcomes implied by 'engineering' and better embody intentionality and human agency in the process. But to me the terminology also appears culturally narrow and

inappropriate, perhaps reflecting a US understanding of 'intervention' as an undesirable change imposed from elsewhere (for example to tackle addiction). By contrast in UK English, 'intervention' lacks that negative tenor, and using it here would appear rather to actively soften the idea of geoengineering, in a way one might pursue if hoping to enhance its public acceptability. To some degree the usages of geoengineering, and climate engineering seem to represent a similar split, with the latter term embodying the particular purpose more clearly, but also thereby (in different parts of the world) making the concept more or less palatable in public discourse. I should acknowledge here that the terminology in the various papers differs – less from careful consideration, than from accidents of timing and fashion - but the broad definitions used have been consistent.

In this document I work with the terminology of 'climate geoengineering' (with CGE as the standard acronym), and a broadly accepted (if blurry) definition of 'large-scale, intentional interventions in earth and/or climate systems with the aim of reversing or reducing the rate or impacts of anthropogenic climate change' (Royal Society 2009, NAS 2015a&b). I recognize strong arguments for finer grain definitions (Heyward 2013, Royal Society 2009), and at times discuss specific techniques or groups of techniques separately. Often I distinguish between solar radiation management (SRM) and carbon dioxide removal (CDR) approaches, and indeed *Papers 1* and *2* focus almost entirely on SRM. However, to accept a particular categorization rather than considering climate engineering in the round would be premature. SRM and CDR share commonalities that go beyond their asserted purpose, such as the ways in which they might interact with other climate responses. And if, as I argue elsewhere (see Section 4.2, and *Paper 1*), the potential for mitigation deterrence in its various forms is the most significant ethical concern or justice issue arising from CGE, then it would appear that one such commonality is critical. There are also some commonalities in discursive framing, especially between stratospheric aerosol injection (an SRM technique) and ocean iron fertilization (a CDR technique), both of which are widely discussed in popular media articles on CGE. Both fit the broader narratives of high-tech natural analogues (see *Paper 4*), with high leverage and scope for unilateral action, and considerable uncertainty about the risks involved. These two technologies therefore arguably suit media agendas, in which some controversy is desirable.

Moreover, both SRM and CDR are responses to climate change in a situation where humanity has already emitted dangerous levels of greenhouse gases. This distinguishes them clearly from mitigation, although potentially aligns them more with adaptation. SRM and CDR also share a status as technological imaginaries (at least at the scales required to be

effective in their stated purposes). This too argues for considering them together. Moreover, there are other dimensions beyond the technological form, according to which CGE approaches might alternatively be categorized (Heyward 2013, Royal Society 2009).

Nonetheless some form of boundary is necessary – or else this text would be even longer, and completely uncontrollable. So, firstly, I try to insist on the 'intentional' aspect of the definition – thus excluding ongoing releases of carbon dioxide, or of artificial fertilizers (both of which might be seen as 'large-scale human interventions in earth-systems with impacts on the climate' (Morton 2015)). The issue of intentionality is often considered to carry significant moral weight (Heyward 2014, Morrow 2014a), which may prove of relevance in assessing the ethical status of climate engineering, although, as I argue elsewhere in this chapter, conceptions of justice which rely on intentionality and agency to establish duties or responsibilities are too narrow to fairly address issues like climate change where oppression, domination and uneven harms are emergent and unintended effects. As Young (1990) argues, institutional remedies are needed to address unintended cultural oppression as much as to prevent intentional discrimination. Secondly, I also broadly adhere to the 'targeting climate change' aspect of the definition, and do not consider other potential uses of the same technologies or techniques. Nonetheless, alternative uses, such as applications designed to increase (or decrease) agricultural yields, may be highly significant for justice, especially with respect to SRM technologies that might appear controllable and targetable (Keith 2013). Such applications of climate engineering, however, are only addressed incidentally (they are touched on in *Paper 2*, and the framing effects of considering CGE as purely related to climate are briefly discussed in *Paper 3*).

So to summarize on the scope of CGE, I consider here a range of techniques and approaches that can be defined as deliberate climate geoengineering, aiming to reverse or reduce climate change or its impacts, including both SRM and CDR forms, while recognizing the significant degree to which definitions and categorizations are part of ongoing discursive contestation and co-production of socio-technical systems (see 'moral technologies' below). Where I do focus on implications or characteristics that apply to specific forms of CGE - such as the high leverage of SRM (see Section 4.2) – I aim to make that explicit.

2.2 Defining Justice

My understandings of justice are as provisional as those of CGE just outlined. Rather than assuming the independent existence of a universal or ideal form of justice to which societies can aspire, and against which our progress can be evaluated, I recognize justice, morals and

ethics as plural, contested and negotiated, with new challenges and frontiers co-created by moral reasoning, cultural evolution and technological progress - amongst other things (Malik 2014, Minteer 2011, Haidt 2007, Appiah 2010).

The concept of justice is itself ill-defined. Most of us, I suspect, believe that we know justice (and its opposite: injustice) when we see it, but pinning it down is trickier. Plato considered justice to be 'an overarching virtue' in both individuals and societies (LeBar and Slote, 2016). Such a capacious interpretation would make justice largely interchangeable with ethics, and most modern moral philosophers prefer to consider justice as a sub-set of ethics, concerned primarily with what (duties, treatment or behavior) we owe to others (while the broader 'ethics' describes right and wrong ways of behaving). Justice can be considered to arise in three principal domains: the *distributive* (how should goods (and harms) be fairly distributed amongst people); the *procedural* (how can decisions be made fairly in society); and the *corrective* (how should we respond fairly to those whose actions cause harms). Corrective justice is predominantly the domain of the legal system, and especially the criminal justice system, but not exclusively so, and – as we shall see – conceptions of restorative justice (as opposed to punitive approaches) have wide application. This categorization however begs the question of how the moral community within which questions of distribution, procedure and correction apply is defined. This is also a question of justice: who is recognized as a member of that community. To address this I also include consideration of *recognitional* justice, which addresses not only inclusion or exclusion *per se* but also how society fairly includes those of different cultures, backgrounds and identities. Although I use justice and fairness largely interchangeably (rather than reserving justice for procedural questions or the duties of the state, or getting into distinctions based on the role of luck) this does not imply Rawlsian thinking about justice as fairness (Rawls 1971), which is – from my perspective – simply one more culturally embodied conception of justice, albeit a highly influential one in the modern world. More broadly I follow Amartya Sen both in his critique of transcendental reasoning and his defense of the desirability and possibility of some form of non-parochial evaluation of culturally embodied morals and norms (Sen 2009).

Environmental justice scholars (as discussed below, in Section 2.6) typically consider justice as a multi-dimensional concern, with references typically encompassing distributive, procedural and recognitional perspectives (Schlosberg 2007) and a morally normative stance. In contrast with moral philosophy, environmental justice scholarship takes a much more responsive approach to justice, embracing the validity of demands, claims and lived experiences, alongside rational reasoning. The justice implications of climate change and

climate policy have been explored by a range of moral philosophers and environmental justice scholars (e.g. Gardiner 2006 & 2011, Jamieson 2010, Moellendorf 2012, Shue 1993, Athanasiou and Baer 2002). Climate justice concerns embrace intra- and intergenerational distributional questions (both domestic and international), procedural and recognitional issues, and also corrective issues, with consideration of historical responsibility being central to questions of accountability, liability, compensation and reparation (Gardiner 2011a, Heyward 2014, Maltais and McKinnon 2015). Questions of climate justice have been central to international climate negotiations under the UN Framework Convention on Climate Change, in particular in terms of what 'common but differentiated responsibility' might mean in practice, and the ways in which burdens of mitigation and adaptation might be fairly distributed.

My engagement with questions of justice is normative both in the sense of evaluatively seeking to understand what is *morally right*, and in the sense of similarly understanding what is *culturally appropriate* or expected (Ingram 2006). These different senses can collide where accepted social norms appear to legitimate morally unjust practices (Appiah 2010). In any effort to consider justice beyond a particular society, or in a dynamic context, such conflicts come to the fore. Here politics is understood – in part - as a process in which such norms are questioned and reconfigured.

Following these definitions, I turn to the four theoretical and conceptual foundations underpinning the thesis.

2.3 Foundation 1: Social imaginaries, presuppositions and discursive structures

Here I outline the concept of the social imaginary, and its significance. In particular I highlight the way in which the social imaginary intermediates the effects of both technology and human agency in co-producing futures (an understanding without which it is infeasible to evaluate – or even predict - the likely possible effects of CGE). I go on to indicate some of the ways in which distinct social imaginaries can be detected and identified in the background of the five papers, and suggest ways in which an understanding of social imaginaries enriches the analysis of CGE. Notably, an understanding of the dominant global social imaginary – that found in modern, (neo)liberal, capitalist states, particularly, but not exclusively, those of the colonial metropole - allows us to see how CGE promises to sustain such arrangements and ideologies, rather than encouraging their transformation in line with climate justice.

A social imaginary constitutes a set of beliefs and assumptions shared across a society, culture or discipline. In particular it includes beliefs about subjectivity, the nature of social existence and the nature of rationality, a set of 'expectations about how social life should work' (Groves, 2014: 76). It also embraces understandings and beliefs regarding the political economy of society.

Like Kuhnian paradigms and Inayatullah's archetypes (2004, 20008), social imaginaries are largely invisible (presupposed) by those working or living within them, and it is therefore unsurprising that the concepts originated and were initially explored in anthropological (Appadurai 1990) and sociological thinking (Taylor 2003) with their traditions of cultural comparison. Groves (2014) has developed the concept in powerful new directions, applying it at the intersection of moral philosophy and STS. Drawing on Charles Taylor (2003), Alasdair MacIntyre's insight that 'morality presupposes a sociology'; Ian Hacking's concept of 'styles of thought' (sets of cognitive habits that define what counts as knowledge and rationality); and Michel Foucault's 'discursive formulations' (practices for representing and ordering the world), Groves outlines the characteristics of an 'administrative' or 'managerial' social imaginary that underlies modern liberal and economic interpretations of our social and moral world. The subject of this social imaginary – even in the work of justice philosophers such as Rawls (says Groves) - is a self-interested, individual, consumer, with agency to rationally evaluate and choose, and whose interest in goods and 'bads' is instrumental and consequential. This holds whether the moral objective is utilitarian or egalitarian.

Groves' administrative social imaginary is predominant in the modern 'Northern' world, especially in Anglo-Saxon societies, and has been prevalent for decades (with roots that extend several centuries to the 'enlightenment' era). Its characteristics are modernist (rather than pre- or post-modern), capitalist, managerial (especially with respect to risk), liberal (even neo-liberal), individualist in subjectivity, consequentialist (or even utilitarian) in ethics (with priority given to procedural fairness over substantive distributional outcomes), economistic (with science and technology seen as primary drivers of growth and wellbeing), and depoliticized (in the sense that politics is understood as about administering and facilitating the economy).

The dominant social imaginary reproduces its dominance – *inter alia* - through disciplinary norms of scholarship, such as the conventions necessary for publication in leading journals. Connell (2007) describes the ways in which the academic disciplines and practices of the metropole dominate sociology – such that potentials for indigenous, post-colonial, and

'southern theory' are suppressed. In this respect the dominant social imaginary globally is rather the metropolitan vision of what society is and how we should talk about it, acting as a self-disciplining habitus (Bourdieu 1984). Illustrating another mechanism, Henrich et al (2010) show how virtually all psychological scholarship examines a limited population (dominated not just by US citizens, but by university students within the US). The result is that scholars have sought to universalize findings based on what Henrich et al describe as a WEIRD group: white, educated, industrialized, rich and democratic. Their study not only provides a salutary warning against the assumption that conceptions of justice can be extrapolated from this group to all cultures, but also indicates that the social imaginary dominant in the same countries may be reproduced by similar misplaced assumptions about knowledge and rationality.

Social imaginaries both reflect and construct the findings and practice of research and scholarship. They paradigmatically structure underlying ontological and epistemological beliefs, but are not immune to challenge and transformation or replacement. Yet unlike Kuhnian paradigms, social imaginaries function across diverse disciplines and sectors. In discourse terms they are powerful constraining master- or meta-frames (see *Paper 4*), cultural archetypes, myths and metaphors that underpin discourses (Inayatullah 2004, 2008). Underlying social imaginaries not only structure our understanding, but also deny the possibility of accurate anticipation regarding the potential of an emerging technology to shape new futures. The extant dominant social imaginary furthermore unhelpfully privileges anticipatory processes like foresight as ways of managing future uncertainty in contrast to ethics of care or ideas of resilience (Groves 2014).

I use the idea of the social imaginary to describe the co-constructed, and co-producing interface between our perceptions and the world, as a way of critically engaging with the processes that configure and reconfigure human experienced lifeworlds and timescapes. This engagement provides a framework which helps to surface and interrogate the presuppositions which underpin analysis, claims and discourses (in this case regarding CGE). It allows me to reflect on the culturally and temporally situated nature of both knowledge and moral values, while avoiding a descent into relativism, insofar as the concept bridges social constructivism, and critical realism. My interpretation of social imaginaries has many similarities with Jasanoff's concept of socio-technical imaginaries (2015). However it is not only a descriptive or analytic tool for examining future (as yet imagined) socio-technical systems, but also a normative tool enabling evaluative comparison of current and possible future states.

Methodologically, social imaginaries are challenging, as they imply to some extent not just competing epistemologies regarding an objective world; but the potential for 'jostling ontologies' (Tyfield forthcoming), co-producing our worlds and their futures. My concern here is not to establish ontological certainty, but to recognize that regardless of the extent of an 'objective reality', in important ways futures are co-created in the interactions of human and non-human agents which are themselves not entirely autonomous individuals but also the product of ongoing relationships (Groves 2014), particularly affective relationships of attachment (both chosen and unchosen) (Held 2006). In these settings, as further discussed in Section 2.5, individual autonomy and agency is therefore not only constrained and structured by the exercise of active and cultural power (Bourdieu 1984, Foucault 1991, 1998), but shaped by communities, norms and affective relationships (Groves 2014).

Although consideration of social imaginaries reveals ways in which agency is limited, they are not hegemonic and determining – they rather act to foreclose, constrain and delegitimize debate regarding alternative presumptions and epistemologies. For example, modernist managerial social imaginaries allow debate between liberal and libertarian concepts of justice; but largely exclude virtue based or care based conceptions from mainstream discourse. Similarly, social imaginaries are a temporally embedded and contingent phenomenon – they not only can, but can be expected to, change over long periods of time. This simultaneously reflects Groves' concern that approaches to intergenerational justice rooted in contemporary social imaginaries may be inapplicable to future people, and his quest for a social imaginary that can overcome the documented limitations of contemporary justice theory (such as Parfit's non-identity problem (Parfit 1983)). As Groves argues, assessments of justice with respect to the long time-frames of issues like climate change are necessarily contingent on our ways of apprehending the future (prediction, anticipation, risk-management and so forth). And such evaluations are therefore always challenged by emergent outcomes and by issues of reflexivity.

Groves' response is the prospect of care-based social imaginaries, that begin from the premise that human identity and agency is forged and embodied in relationships of care, that such relationships offer ways of building resilience against the inevitable uncertainty (even unknowability) of the future – an uncertainty that is in significant part emergently produced by the continuing interaction of humans and technologies (see Section 2.4 Foundation 2: Co-production, socio-technical systems and moral technologies. Groves does not simply argue that alternative care-based imaginaries are plausible, but that they are

morally preferable to the dominant administrative ones. The subjects of care-based imaginaries are also arguably more 'realistic' descriptions of human subjects, insofar as they are affective, evaluative beings (Sayer, 2011) whose behaviors are rooted not only in rational choice but also in affective relationships of attachment (to people, places and things). *Paper 5* explores some aspects of a care-based imaginary in its discussion of ethics of repair and its suggestions regarding care and integrity.

The insights provided by the framework of the social imaginary also help illuminate the analytic and normative importance of a political interpretation of recognition (argued in Chapter 5) as a means by which social imaginaries might be exposed to reconfiguration and re-construction by a more diverse group of subjects. Such reconfiguration can be achieved not only by recognizing new groups (physically extending to boundaries of society), but by recognizing new identities within existing populations, validating and valuing the different expressions of needs, interests and relations to others and to goods and bads that those identities embody. Arguably this is what care ethics (as applied in *Paper 5*) does by recognizing and validating the (predominantly female, and arguably 'feminine') practices and values of care: it recognizes women not just as people but as (in a distinctive way) carers, and in doing so opens the way for a reconfiguration of social imaginaries, away from individual subjectivity and towards relational subjectivity. In this interpretation social imaginaries can be seen as manifested in the set of institutions co-produced by the politically included (Rancière's *police (2004)*) – highlighting the importance of mechanisms and relationships (such as recognition) that can cross the boundaries of the *police* and offer transformative potential. Such mechanisms might include those identified by Appadurai (1990) as sources of new social imaginaries: cultural flows embodied in migrants, media, technology, capital and ideology. On the other hand, Jasanoff (2016) highlights the ways in which three of these - technology, capital and ideology - tend to act to constrain agency, producing apparently rational actors in an administrative post-political setting.

In applying the idea, unlike Appadurai I don't treat social imaginaries as primarily the active choices of independent agents – but rather as conditioned (but not entirely determined). They are simultaneously hopes and visions for good futures; yet structured and disciplined by, *inter alia*, technology and law (Jasanoff 2015).

Social Imaginaries and CGE

The dominant risk-based, administrative social imaginary is visible in the background in *Papers 1, 2* and *4*. The climate-risk approach to policy framing that *Paper 1* identifies as the

source of mitigation deterrence illustrates the administrative imaginary as described by Groves, for whom "the practices of [CGE] … may discourage political and social efforts at mitigation by reinforcing a tradition of seeking top-down, control-oriented policy and technological interventions" (2014: 204) by those whose power and agency reflects the individualistic rational ideal. Groves emphasizes the ways in which CGE might deny responsibility to future generations by alienating humanity from nature, reinforcing ideals of autonomy, and (echoing Hourdequin, 2012) allowing us to "go on failing to make the kinds of reciprocal, solidaristic commitments that mitigation and adaptation require" (Groves, 2014: 206). *Paper 2* identifies similar tendencies to managerial and top-down control in the assumptions and presumptions of modelers about CGE technologies, control systems and modeling methods, which offer an optimistic impression of the potential justice implications of CGE – but simultaneously expose the narrow conceptions of justice associated with the administrative imaginary: predominantly utilitarian and consequentialist. *Paper 4* describes a set of framings, narratives and discourses of climate change and CGE which in their technological optimism and post-political solutionism epitomize the administrative social imaginary, and indicates the ways in which such a social imaginary may be (re)constructed in narratives about particular activities, challenges and technologies. The dominant framings it identifies for CGE (technological optimism, political realism, catastrophism, and the clean sheet) reflect the ways in which scientific knowledge and scientific progress are privileged in the administrative imaginary – at least where they act to serve the interests of existing power (an expectation identified and feared by participants in the focus groups reported in *Paper 3*, in terms of concerns about the ways in which commercial interests and political moral hazard could converge). *Paper 5* sketches some of the possible dimensions and implications of an alternative care-based imaginary.

Identifying and naming the social imaginary is helpful to my study in several respects. It problematizes agency in a manageable way, as structured and constrained, but not eliminated. It provides a tool for evaluating stances towards the future, which also highlights the possibility of transformed circumstances. It highlights commonalities in presuppositions across disciplines and cultures, which are in turn the aspects of those cultures most likely to be mistakenly considered universal in both time and space. Finally it fundamentally challenges the 'rational/objective' vs. 'cultural/emotional/subjective' dualism (Sayer 2011) that scientific actors in the CGE space consistently reproduce.

The key takeaway here is that social imaginaries, academic paradigms and epistemologies and moral philosophies that are based unquestioningly on autonomous subjects are

fundamentally unable to provide 'really useful' (Scandrett 2013) or emancipating (Wright 2010) guidance for (constrained yet significant) human choices and actions. Moreover, the pursuit of ever more precise or further-reaching anticipatory and administrative ways of predicting and managing futures is doomed where the mental (and computer) models involved fundamentally misrepresent the subjects involved. This is not just a critique of neoclassical economic approaches and the utilitarian judgments they tend to support, but also of much of universalist liberal moral philosophy, and (from the other direction) of sociology that treats human agency as irrelevant within structural constraints (see Section 2.5).

2.4 Foundation 2: Co-production, socio-technical systems and moral technologies

Having recognized the significance of social imaginaries, here I turn to the role of technology. I outline concepts of co-production and socio-technical systems (borrowed from Science and Technology Studies (STS)), to illustrate the role of technology as both produced by and reconstructing social imaginaries, and key ways in which technologies further condition, structure, limit or empower human agency. This conceptual framework suggests that human and technological agency are also coproduced; such that the outcomes of the use of technologies go beyond the decisions of the immediate users, implying a broader distribution of moral responsibility. I indicate ways in which the moral and political characteristics of technologies might be apprehended, including some that appear in the five papers. I summarize how this understanding of technology can assist in the evaluation of CGE, highlighting the shortcomings of STS engagement with questions of justice in this respect. In particular, I indicate how the consequences of CGE – especially through depoliticization - might act to sustain the dominant social imaginary, increasing the risks of mitigation deterrence.

Theory from STS illuminates an understanding of (climate geoengineering) technologies as co-produced, and necessarily embedded in socio-technical systems (Jasanoff 2004, 2015, Wynne 2016, Stirling 2008, Tyfield 2012). Understood this way, technologies inevitably have moral and political implications (Winner 1977, Verbeek 2011, Cotton 2014). They reconfigure our ethical and political landscapes and choices (Mamo and Fishman, 2013), typically introducing new possibilities (Verbeek 2011), but at the same time structuring human agency; and thus limiting or magnifying power. As Stilgoe (2015:23) suggests: "by creating new capabilities, [technologies] always change social relationships … and reshape lives" with uneven and often unpredictably distributed risks and benefits. And critical STS

exposes "the ways sciences, knowledges, and technologies maintain, reproduce, and transform power relations" (Mamo and Fishman 2013: 166). The implications for our understandings and interpretations of risk and moral agency are significant. While technologies understood this way have some limited agency, it is of a form that shifts some moral responsibility for the outcomes of the use of the technology from the human user to the human designer, rather than vesting moral responsibility in an autonomous technology. Drawing on actor-network theory (Latour, 2005) such agency is therefore more a characteristic of the relational network of heterogeneous human and non-human components (the socio-technical system) rather than of a particular actor.[7] In considering the moral, ethical or justice implications of a socio-technical system, an absence of intentionality might seem problematic. However, it is not necessary to subscribe to strict equivalence of human and non-human agency to accept that in imbricated socio-technical systems, non-humans can have some degree of agency, while human agency is to some degree constrained and conditioned by the relationships within the system. Such limited and constrained forms of agency can still be subject to moral considerations, and have implications for justice in several ways, with ethical duties arising for designers, users and regulators of technologies.

To treat technologies as wholly autonomous would support both dystopian and utopian discourses – for example as seen in the Promethean post-political treatments of CGE discussed in *Paper 4*. It would also squeeze out questions of responsibility (Stilgoe, 2015) and reduce regulative options to simple 'prohibition', rather than nuanced forms of accountability and liability, for example. Understood rather as systemically embedded, technologies may have relevant tendencies, such as centralizing power (Szerszynski et al 2013), or encouraging more risky behavior, for example in the form of mitigation deterrence (*Paper 1*). But these are not essential characteristics of some abstract, objective technology whose form flows directly from the related physical and natural sciences. They are rather a co-produced outcome of literal and metaphorical dialogues between developers, users, and other stakeholders.

STS perspectives make clear that the very identity of a technology is negotiated and contested, not only in debate within the scientific community, but in differing visions of its purpose or potential, fought out in public, political and economic arenas (even though the

[7] Agency is discussed at greater length below in Foundation 3.

actors engaged in such discursive contests tend to perceive and portray technologies in essentialist fashion (Wynne and Felt 2007)). Discourses are not treated here simply as linguistic structures, but following Foucault (1998), as powerful institutionalized patterns of knowledge. Claims or assumptions of objectivity and neutrality in language therefore always demand interrogation. Critical discourse analysis (Fairclough, 1995) is therefore an essential tool in understanding these effects, even from a perspective of critical realism that rejects conceptualizations of technologies purely as discourse or narrative (Archer et al 2016). More precisely, the capacity of technologies to constrain or reconfigure choices suggests what might be described as a 'critical re-constructivist' view in which realities are indeed discovered, (re)constructed or reconfigured by discourses, but still have an existence independent of discourse (so they can also be – in part or in theory at least - discovered, understood and reconfigured in other ways).

Practical future-oriented responses to the governance of technology and its development, such as foresight, public engagement, anticipation and responsible innovation (Owen et al 2013, Stilgoe 2015) can be seen as efforts to widen relevant dialogues (and particularly better to include less powerful stakeholders, and their views, in the discursive contests (Stirling 2008)). But such processes must be reflexive too, as otherwise they may unthinkingly constitute publics or interests that reflect unquestioned presumptions and existing power arrangements (Chilvers and Kearnes 2016, Bellamy and Lezaun 2015, *Paper 3*).

Despite the moral consequences of its understandings of technology, STS has only weakly engaged with emergent questions of justice. For instance Mamo and Fishman (2013) see little dialogue between the diverse scholarly perspectives that have taken up ethical issues in science, knowledge, and technology, and a paucity of attention to justice as distinct from ethics, despite "an overlapping field of inquiry in need of in-depth theorization" (Mamo and Fishman 2013: 162-3). Literature on ethics in science as opposed to explicit attention to justice, they say, can obscure issues of politics, power, and inequality. They argue that it would be possible and desirable to "use STS modes of interpretation to ground and nuance justice frameworks to allow for greater theorization, specificity, and interpretation" (2013: 163). Ottinger (2013) argues that STS needs more sophisticated concepts of procedural justice, for example to "include proactive knowledge production to fill in knowledge gaps, and ongoing opportunities for communities to consent to the presence of hazards as local

knowledge emerges and scientific knowledge changes" (p251).[8] Svarstad and Benjaminson (2015) go further and argue for approaches to procedural justice as part of a broader concept of environmental justice that better incorporates questions of power.

Stilgoe also criticizes dominant approaches to ethics in STS. In particular he suggests that the practice of 'speculative ethics' "downplays the uncertainties of technological futures in its search for implications" (2015: 40) and even acts to strengthen technological imaginaries in the very forms it seeks to challenge. Stilgoe does not question the normative motivations of such speculative ethicists, but portrays them as naïve in considering that they can forecast ethical implications without helping consolidate particular technological imaginaries. On the other hand, Mamo and Fishman (2013) fear that STS scholars (embedded in interpretive approaches) shy away from the evaluative implications of the terminology of justice, treating justice as (simply another) research object. By contrast, they suggest those that see justice as a normative goal are more likely to engage activists and communities in research and theorizing – a central practice of environmental justice scholarship (see below) and also a common practice in political ecology (Svarstad and Benjaminson 2015).

Like Sayer (2011), Mamo and Fishman (2013) seek to transcend a normative/descriptive dualism. "While the dual goal of critique and intervention are embedded in critical social science theories, the descriptive modes of intellectual inquiry often stand purposefully apart from normative ones. Such a separation, however, has been shown to be a dead end and one STS must find its way through in order to engage in and with justice." (2013: 165) One reason for such a view might appear simply instrumentalist: without understanding of the evaluative ambitions of humans, we will fail to understand how people use (or resist) technologies. But similar argumentation leads to a normative logic too: unless we interpret and describe these processes we will fail to understand (even if we choose not to realize the opportunity to influence) the evolution and development of moral and ethical values.

Before moving on, I want briefly to highlight some distinctions between 'technology' and 'technologies'. In the above I have consciously used both terms. In interpreting pragmatic ethics and applying ethical principles (such as justice) to socio-technical systems, both technology as a social and political concept, and technologies as specific material manifestations are relevant. In this thesis I am more concerned with the specific

[8] In Foundation 4 I question whether even such more sophisticated procedural approaches are sufficient. But that they are lacking in STS scholarship highlights a significant gap with respect to justice.

technologies of CGE and their emerging expressions in socio-technical systems, than the overall concept of technology.

In recent years, STS understandings have been at the forefront of explorations of public responses to technologies such as nuclear power, genetic modification, nano-technology, and carbon capture and storage (Stirling 2014, 2015, Pidgeon and Rogers-Hayden 2007, Pidgeon et al 2014; Wynne 2016). STS reminds us that public 'unease' or 'distrust' of science is typically not a generic opposition to technology (singular), and should not be called upon as an explanation of apparent opposition to particular technologies or applications (*Paper 3* confirms this). In practice, concerns are generated by related social and normative factors such as vested interests: "public misgivings over the *purposes and interests* behind innovations are often misunderstood as if they are concerns about safety as defined by regulatory science and expertise" (Wynne and Felt 2007: 10, emphasis added). And, suggest Wynne and Felt, "the tendency to collapse these normative dimensions into technical assessments of 'risk perception', and to dismiss public concerns as irrational, is itself a major source of concern" (2007: 11). This again clearly illustrates dimensions of the dominant administrative social imaginary identified by Groves (2014).

And that dominant social imaginary reproduces a particular (and misleading) conception of 'technology' as a signifier of innovation and driver of economic progress, instantiated in a diverse set of objective material products whose ethical implications are determined in use (as seen in the discourses around CGE technologies explored in *Papers 2* and *4*). The dominant social imaginary view of technology and economic progress could also be seen in the public expectations reported in *Paper 3* regarding perceived motivations for CGE research. Moreover, this dominant conception of technology empowers pursuit of technological fixes (Borgmann 2012, Markusson et al 2017, Stilgoe 2015) and fuels a broader notion of technological solutionism (Morozov 2013), which sees issues as problems in search of a solution, rather than challenges in need of management (and care). As Hulme (2009, 2014) argues cogently, treating climate change in such a way underlies not only the disagreements that have marked climate politics, but also the narrow pursuit of CGE as a response.

STS and CGE

Under this heading I focus attention briefly on the ways in which the STS approaches set out above can be of particular relevance in investigation and evaluation of CGE.

At the risk of creating a straw-man, much of the literature on CGE treats it as a predictable and objective technology, rather than a co-produced socio-technical system (or indeed as an imaginary system). It overlooks the depth of ignorance involved (Stirling 2003) and fails to acknowledge the extent of emergence, uncertainty and ambiguity (Stilgoe, 2015). As a result the research, modeling, and speculative ethics appear to be unintentionally conspiring to reify and naturalize CGE (Stilgoe 2015; Wiertz 2016). Stilgoe (2015) argues that this problem implies a need for more iterative and engaging interdisciplinary experimentation and reflection. Galarraga and Szerszynski (2012) argue for new *imaginaries of making* that supplant the 'climate architect' able to design and direct CGE, with 'climate artisans' and 'climate artists.' Like Hulme (2014) such authors are concerned to ensure that humanity does not mistakenly presume that CGE is possible (or at least controllable and manageable). If scientists are wrong in such expectations, research is potentially problematic in two broad ways. The first is that it might lead to deployment of technologies with more directly harmful than helpful effects. The prospect of such severe unintended direct consequences, even from SAI, seems unlikely (regardless of concerns regarding drought raised by some modeling exercises – see *Paper 2*). However the second seems more significant: if the prospect of controllable and manageable CGE reduces mitigation effort (*Paper 1*'s mitigation deterrence), but then is not delivered, the harms are very clear and could be substantial.

Much of the CGE literature treats the scientific knowledge and technological concepts involved as if they were purely aspects of an objective reality, simply waiting to be discovered (and, as Stilgoe (2015) notes, this is true of the ethics literature as well as the scientific and economic). While there is some recognition that the techniques of climate engineering are (almost entirely) imaginary conceptions of potential future devices or methods, this is often treated as simply a descriptive term: they are imaginaries because they have yet to be constructed in reality. The ways in which those imaginaries – or indeed existing physical technologies – can co-produce scientific endeavor and new knowledge in ways that reshape politics, culture and society, such that particular emanations of these potential technologies do, or do not arise in practice, are little considered.

Yet such processes of co-production are endemic in CGE scholarship. The imaginaries here (particularly those expressed in climate modeling) act to structure the design of the technologies, and the technologies in turn structure the models, feeding back into the selection of parameters and the refinements made (Wiertz 2016; Stilgoe 2015). *Paper 2* explores how this process works for SRM, but it is true of CDR too (Geden 2013, 2015). In particular, Bioenergy with CCS (BECCS) has been constituted as an imagined full-scale

technology by the demands of climate pathways modeling to make carbon budgets add up.[9] The framings that technologies like BECCS and SRM co-produce are explored in *Paper 4*, which suggests that they are bound into politically sustaining, technologically optimistic narratives of *ecological modernization* and even *technological prometheanism*. Furthermore such framings can be further reinforced by public engagement that helps construct publics around the technologies (especially in forms which are unreflective of the ways in which they constitute the initial learning experience of participants regarding CGE). Opinion survey work (e.g. Carr et al 2012) can be more vulnerable to this effect even than deliberative engagement (Parkhill et al 2013, Pidgeon et al 2013, and *Paper 3*). In opinion survey work there is no space for emergent, unanticipated findings, whereas in deliberative engagement this possibility is real, especially where the discussion space is kept open. For example, in the deliberations recounted in *Paper 3*, the ways in which the publics involved sought to link technologies, elite interests and negative distributional consequences (such as environmental dumping) were not anticipated. Research using multi-criteria mapping suggests that where publics are allowed to define the issues or criteria for evaluation as well as the weightings and scorings, the relative preferences for different climate policies vary dramatically (Bellamy et al 2013, 2014) as a result of opening up the discussion (Stirling 2008). Macnaghten and Szerszynski (2012) also found deeper public disquiet over SRM when they did not actively frame it as a response to climate change. All of these concerns raise the prospect of an undesirable and premature 'lock-in' of particular emanations of CGE technological imaginaries.

By understanding technologies as socially embedded (and analyzing their development in terms of discourses and archetypes) we gain better understanding of the role social constructions of technology play in neo-liberal and post-political visions of society (as discussed above in Foundation 1; in *Paper 4*; and by Swyngedouw (2010)). Within a technocratic, administrative rationality, technology generically acts as a tool of political control and economic conservatism. Within the dominant social imaginary, technology at most supports a managerial transition (Geels 2002, Stirling 2015) as indicated in *Paper 4*'s analysis of ecomodernist framings. In ecological modernization (and technological promethean) discourses, not only CGE, but also CCS, nuclear power, and even renewables

[9] The problem is exacerbated because the modeling also accepts lazy carbon accounting which overestimates the possible carbon gains, and makes presumptions that fail to recognize the victims of large-scale biomass planting (and the knowledge they and their allies bring about the real-life carbon accounting of biomass) properly (Searchinger et al 2009; Kartha and Dooley 2016).

can be understood as products of a quest to avoid social and political transformation in the face of climate change. My argument is that such controlling and conservative applications of technology are facilitated by the framing out of justice, and the failure of recognition of the groups (human and non-human) which might bring radical transformations into politics.

Moreover the technological optimism inherent in such framings privileges innovation over maintenance and repair. Yet repair (as an inflection of care) is central to a technological society. Socio-technical systems are constitutively networks, and when networks 'break down' they become collections of distinct parts, rather than functioning wholes. Thus the maintenance of a technology, and equally of a social norm, an institution, or a theoretical concept, depends on the robustness and maintenance (or care for) the network that underpins it. Jackson (2014) highlights the value of 'broken world' thinking as a mode of analysis for modern society which seeks to reveal the degree of dependence on repair, and the politics and distributional implications of the ways in which repair is concealed. *Paper 5* makes an initial effort at reframing the social imaginary in terms of care and repair, drawing in part on approaches to repair developed in STS thinking (Graham and Thrift 2007, Hobson 2016) and reflecting the ideas of care and attachment in repair for sustainability (Groves 2014). *Paper 5* also argues that repair is not necessarily a conservative, sustaining impulse, but potentially transformative, especially when we seek genuine recognition for those undertaking care, maintenance and repair, from women providing daily domestic care, to Bangladeshi shipbreakers and Pakistani e-waste recyclers, and to microbes in our guts and soil. The importance of recognition is discussed at greater length in Chapter 5.

2.5 Foundation 3: Conditioned agency, power and politics

In the discussion above, I have been at pains to emphasize that neither social imaginaries nor moral technologies remove agency from human actors. Instead each exerts power in ways that condition agency (both constraining and empowering in different ways). Here I briefly discuss some conceptions of power and agency that help explain the approach I take to CGE, and relate them to understandings of politics and governance. In particular I note how power – especially in depoliticized forms - contributes to the generation, maintenance and reconstruction of social imaginaries and socio-technical systems.

At its simplest, power can be understood as asymmetric agency (Stirling 2014). Asymmetric agency can be seen both as a state of injustice (a lack of freedom or capability) and a consequence of distributional injustices. Agency may be enhanced or constrained by the effects of inequalities, technology, capabilities, vulnerabilities, recognition, and social

imaginaries amongst other things. Agency can also be constrained by the exercise of power, both directly in the form of domination and 'power over' and indirectly, for example, through self-disciplining effects that normatively structure and constrain 'power to' (Foucault 1991, 1998, Bourdieu 1984, McNay 2008).

This thesis is not going to resolve the question of agency and determinism, but I do want to problematize agency and identity beyond the simplistic conceptions that inform public and political discourses about both technology and justice. Suffice to say that without some degree of agency (and associated choice and intentionality), justice arguably becomes meaningless (Malik 2014). However the predominant conceptions of agency in dominant social imaginaries - those associated with rationally choosing, materially-motivated, autonomous individual consumers – are clearly too simplistic. Not only can they be criticized for misconceiving motivations and rationality (as cognitive science and behavioral economics reveal); but they ignore the ways in which agency is structured or conditioned and distributed in society. Sen and Nussbaum's capabilities approach gives us one way to understanding limits on agency: individuals need a wide range of capabilities – from good health and education to political rights and a sustaining environment, if they are to be able to act in society so as to live lives they value. But capabilities theory still has something of a blind spot with respect to how power is exerted structurally, habitually, and discursively by elites, leading to reproduction of inequalities such as those of class, race and gender.

Here it helps to briefly draw on Bourdieu's concept of habitus, as described by McNay (2008). "Habitus yields an account of practical action whose origin is not in freely willed decisions made by the individual but in the values and norms of the collective that the individual has mostly unconsciously internalized" (McNay 2008:72). In the terms introduced earlier this is a helpful extension of the content of the social imaginary. Such collective norms can be emergent, or more typically constitute a 'doxa' – "imposed by a dominant group in order to legitimate its own authority" (McNay 2008:73).

Yet such "symbolic domination presupposes, on the part of those who submit to it, a form of complicity which is neither passive submission to external constraint nor a free adherence to values" (Bourdieu, cited by McNay 2008: 73). It reflects dispositions inculcated by discourse and practice over time; and suggests that both identities and the discursive resources available to individuals to narrate their identities and communicate their agency are severely limited or conditioned by symbolic domination or self-discipline (in Foucault's terms). Yet even this interpretation does not close a door on agency: it suggests potential may remain for dialogical collective action to reconfigure habitus, especially where new discursive

resources are introduced by previously unheard or excluded groups (as explored further in Chapter 5). It implies that a normative quest for justice demands proactive effort to achieve reflexivity over how strategies and practices might reproduce or transform the doxa and habitus of society, or even the social imaginary within which they are constructed and reproduced. In *Paper 5* I begin to explore how new imaginaries rooted in care, repair and recognition might transform our approaches to climate change. Interventions that support and enable care and recognition might also be helpfully understood as ways to enhance agency and capabilities.

The foregoing analysis complements my reading of STS literatures above: understanding technology as embedded and moral does not mean that all outcomes are emergent properties of the system, or that humans lack agency.

In STS perspectives, technologies are understood as merely parts of socio-technical systems in which humans and technology are imbricated, embedded and inter-active. Technology is neither deterministic, nor purely objective, but part of a network of relationships. Actors in an actor network theory (ANT) network only take form through their relations with one another (an insight shared with the 'ethics of care' (Held 2006, Tronto 1993)). The ways in which agency is conditioned in such networks are largely ignored in the dominant social imaginary and in mainstream justice scholarship. ANT approaches draw attention to the 'power to' inherent in networks (such as the structural power of models and modeling to construct technologies and define policy and governance options outlined in *Paper 2*). But ANT does not distinguish the asymmetric capacities or power of humans (collectively or individually), technologies and other non-humans to act within it and rarely considers the scope of dominant networks to centralize and structure 'power over' others. And in conceptualising each network from scratch, actor network theory risks not even recognising pre-existing power structures.

That power shapes our identities, and in particular tends to support the acceptance of sub-ordination, is problematic for justice, not only in distributional terms, but also as recognition – at least in readings of the concept that rely on individual self-identification and claims for recognition (Honneth in Fraser and Honneth 2003). Power to determine living conditions in turn strongly structures subjective identity (McNay 2008). For example patriarchy helps create feminine identities that accommodate and support male domination. This leads McNay to question the ethics of respecting subjective demands and lived experience, echoing the long-standing Marxian debate over 'false consciousness'. It perhaps therefore suggests similar responses, such as popular education, collective public deliberation and

movement building. It does, however, also rebut the idea that meeting subaltern movement demands for recognition would deliver ideal justice, rather than merely enhancing justice in a pragmatic way. Yet McNay's concern should be read as a reason to engage with the processes by which identity is configured, not a reason to reject normative ideas of recognition.

Problematizing power, agency and identity is important in the context of Groves' proposal of an alternative care-based social imaginary, insofar as this relies on to some extent on conceptions of identity and agency shaped in relations of care. But conceptions of power, agency and identity form part of particular social imaginaries. In the dominant social imaginary, for example, power is imagined as a product of representative democracy and governmental institutions, largely obscuring both the agency of collective movements, and the elite power of wealth and corporate interests (which is in turn expressed in the habitus). Thus how we conceptualize agency and identity is itself contingent on the social imaginary. This contingency not only empowers critique such as McNay's (2008), but also underpins hopes that reconstruction of identity arising through reconfiguring habitus can be harnessed to normative aspirations.

This understanding of power and its exercise is also informed by consideration of forms of politics and post-politics. I begin from a broad understanding of politics (following Young, 1990) as collective decision making processes and the contexts in which groups contest and decide collective actions, ways of living together and plans for the future, including institutional organization, public action, social practices and habits and cultural meanings. I also understand political acts as those "engaged in constructing different and selective … realities: material, ideological, imaginative [and] normative" (Hulme 2017: 9). Depoliticization is therefore highly problematic, especially as an expression of the administrative social imaginary (which Young describes as 'welfarism' in modern capitalism). As *Paper 4* notes, ideas of 'post-politics' suggest that spaces of debate and dissensus within society are in various ways being depoliticized, *inter alia* by the removal of many decisions to technocratic and managerial processes. Real power is moved elsewhere by the deliberative discursive reframing of issues and by processes such as technological solutionism (Morozov 2013) which take power from governments and the public, and vest it in technologists and businesses. Technological practices and expertise are also a source of structural environmental injustice (Ottinger 2011). Yet depoliticization undermines a response to such injustice, insofar as it is mobilized to reject moral responsibility. For example, historically, when social differences could be successfully blamed on differences in

climate, this "had the effect of freeing political history from the burdens of moral accountability" (Livingstone cited by Hulme 2017: 69).

Rancière's interpretation of post-politics is also helpful here. Rancière (2004) argues that the critical territory of 'politics proper' is the processes whereby institutions and arrangements for living together are constructed and reconstructed, such that politics proper only occurs where the currently unheard or uncounted (those excluded from society and discourse) force their way in, making themselves heard and counted. Such incursions inevitably transform political institutions, and simultaneously express and reconfigure political agency. They also imply recognition of a previously unrecognized group. Young (1990: 258) prefigures such analysis with the suggestion that to 'repoliticize public life' requires disruption by outsiders (such as international civil society engaging in international politics). Ingram (2006) deepens such analysis with a detailed account – drawing on both Rancière and Hannah Arendt - of politics as a process of widening inclusion and dissensus simultaneously (re)defining justice, and contributing to it (a view elaborated in Section 5.4).

Power and CGE

The evidence presented in *Paper 3* on public deliberation also suggests that agency is not entirely removed, even if severely constrained, by discursive power and depoliticization. In these collective deliberations, UK publics identified and raised concerns over the interests and power relations that they feared would dominate over democratic decision-making and governance of CGE. However, such concerns appear to be routinely overlooked in the objectivist narratives of CGE research advocates - for both SRM and CDR – as outlined in *Paper 4* – reflecting the dominant social imaginary.

As discussed in more detail in Foundation 4, with these understandings of power and agency, it is hard to define 'culpability' for climate damage, but easier to determine 'complicity'. Moreover these approaches emphasize why capacity (of which 'ability to pay' is only one possible expression) is a critical consideration in determining the obligations of justice in cases such as climate change. With respect to the climate issue more generally (as also sketched in *Paper 4*) individuals' 'power to' mitigate is constrained by structured processes of domination, embedded in habits and practices, emergent from processes and decisions made in institutions in turn dominated by elite and commercial interests. These processes emerge within dominant liberal social imaginaries that fail to recognize the limitations to agency arising from difference (from the historic implications of slavery, to the benefits of inherited wealth, and the vulnerability to climate effects arising from

underdevelopment). The political power embedded in fossil fuels that allowed factory owners in the early industrial revolution to bring working practices under control (Malm, 2016) persists to this day. Indeed as fossil fuels have become more deeply entangled in daily life, especially in the form of car-borne mobility, arguably that power has grown. The commercial and political incentives to sustain the fossil economy are immense for those whose positions are underpinned by production and consumption of fossils, and the relative agency of these interest groups is substantial. The efforts of the fossil fuel lobby to deny and distract from climate change (Oreskes and Conway 2010) illustrate this clearly (as also indicated in *Paper 4*). Buck (2012a) notes that CGE researchers do not see CGE as a substitute for mitigation, but argues that the political economy of fossil fuels means that it could be perceived and treated as such. Insofar as the failure of climate policy so far is understood as political economy, a product of the interplay of power and interests, rather than simply an international or intergenerational tragedy of the commons (Gardiner 2006, Moellendorf 2015) or the result of cognitive biases (Marshall 2014), then (as *Paper 1* points out), we should expect advocacy for CGE to be accompanied by further efforts to delay adequate mitigation. This applies to both SRM and CDR approaches.

And CGE, especially in SRM forms, has the potential to further distort the distribution of agency across society. Given the leverage and potency of SAI in particular, in a managed climate, the relative agency and power of the CGE-system managers would be huge, effectively determining the living conditions for the rest of humanity (including potentially many generations of future people), structuring their choices and shaping their capabilities. Even if undertaken benignly, such domination raises grave ethical concerns. As Patrick Taylor Smith (2012) points out, slavery is not justified by a kind slave owner. Nor is colonialism justified by a benign central power. Such domination is intrinsically ethically unjust, and any global deployment of CGE would therefore require widespread participation and accountability to counterbalance these impacts on agency and freedom. Moreover such domination also tends to generate harmful self-disciplining behaviors which make genuine recognition more challenging (Dübgen 2012, Connell 2007). Hulme (2017) notes that the threat of climate change is only the latest emanation of climate as a cultural construction justifying the imposition of centralized or metropolitan governance on local or colonial societies. CGE would appear similar in this respect, but arguably both a more direct exercise of metropolitan power, and simultaneously as a depoliticized technology, one which further removes that power from political debate or democratic control.

Indeed, Szerszynski et al have argued that the technologies involved are inherently undemocratic (2013). I would rather portray this as a tendency, than an essential characteristic, but would agree that in the current international political arena it seems unlikely that CGE could be deployed democratically (see Section 4.2 below). Hulme too (2014) suggests that CGE is ungovernable because it would demand an unprecedented and unattainable degree of global cooperation and trust. Further, the technical capacity to model CGE well enough to attribute effects and feedback into practical governance seems equally unattainable and the belief that it may be appears to be a product of hubris (*Paper 2*). At best this must be understood as a contested space, and the scope for ethical and just governance and regulation of CGE must be problematized.

Too often though, the CGE literature offers simplistic reflections on governance, if any at all (Keith 2013, Lane 2013). Scientists tend to presume simplistic mechanisms of power to govern or regulate, for instance with demands for a 'simple' regulation to require CDR attached to any extraction of fossil fuel (Millar et al 2017). Some SRM boosters on the other hand suggest extremes of post-political technocratic governance that assume away any role for government (Levitt and Dubner 2009, Davies 2013, Lane 2013). Even the more considered governance proposals, such as Parson and Ernst's suggestion to limit influence on governance of CGE to nations that comply with their mitigation commitments (Parson and Ernst 2012) still tend to both essentialize the technology, and simplify power - seeing politics as purely a matter of states and regulators. In the case of CDR, questions of governance are almost entirely flattened to the carbon price and carbon market rules, which are seen as the fundamental tool to incentivize CDR (McLaren 2012a). Corry (in press) notes similarly that treatment of CGE in international politics literature is typically naïve, based on misleading assumptions about state rationality and a generally pacific international system. This naïve view of international governance in part reflects the contemporary Anthropocene framing of the climate debate which tends to reduce humanity to a single actor (Moore 2016), overlooking the diverse interests involved and their asymmetric power and agency.

Simplistic notions of governance also risk overlooking the potential for severe injustice. SRM appears to threaten undemocratic domination (Szerszynski et al 2013; Smith 2012) with little regard for distributed impacts and vulnerabilities (*Paper 2*), as well as a 'security challenge' generated by the way it offers a way for powerful actors to securitize climate action (Corry, in press). CDR might appear less of a threat in these terms, but as well as depoliticization through carbon commodification, the practicalities of technologies such as BECCS and even

biochar make it susceptible to severe injustices through practices like land-grabbing (McLaren 2012a).

2.6 Foundation 4: Plural dimensions and conceptions of justice

In the preceding sections I introduced conceptions of society, technology and power that all act to structure and constrain human agency yet do not preclude treating human agents as subjects of justice. In this section I develop the understanding of justice that underpins this thesis, and in particular, outline a plural conception of justice, which I argue is needed in a world structured by social imaginaries, moral technologies and power. My approach to justice is rooted in environmental justice scholarship, which tends to counterpose plural approaches against the universalist claims of moral philosophy. In this section I also note where plural conceptions of justice feature in the papers, and briefly review how CGE scholarship has engaged with questions of justice. I begin though by briefly reviewing the dominant, individualist themes in contemporary moral philosophy.

Individualistic concepts of justice

Ethics and justice are ancient and evolving concepts (Malik 2014, Stumpf et al 2015, Sen 2009). Many early and mediaeval conceptions of justice appealed to a divine or other natural conception of rightness, and positioned justice as a character virtue. In some Eastern approaches virtue remains central, as do ideas of dedication to the common good (sometimes described as communitarian). In the West, utilitarian approaches that equate justice with maximizing happiness or wellbeing – often associated with John Stuart Mill – have divided from deontological approaches in recent centuries. The latter - epitomized by the work of Immanuel Kant - are rooted in the idea that humans are rational beings worthy of dignity and respect. Despite efforts to reinstitute communitarian approaches (e.g. by Sandel, 2009), more recent Western conceptions primarily measure justice in terms of consequences or outcomes, located in some form of real or notional social contract, or in the rights of individuals, with a focus therefore on distributional and procedural aspects. This underpins a central tension in contemporary justice discourse between liberty (or freedom – a statement of agency), and equality (or fairness) all measured at an individual level. Although egalitarians tend to emphasize fairness, and libertarians prioritize freedom, most theorists attempt to incorporate both elements in some way.

For example, Rawls (1971) argues for maximum equality of rights and liberties, yet for a distributional principle which permits deviations from equality of distribution of primary goods *only* where it would benefit the absolute position of the worst off. Rawls suggests that

such principles would be logically adopted by all actors if they were ignorant of their position in society. It thus constitutes a form of social contract theory, in which moral legitimacy derives from mutual agreement. Such agreement can be derived either consequentially as Rawls does, from mutual self-interest (from cooperation or reduced vulnerability), or deontologically from mutual respect based in a Kantian rationality which demands that each of us treats others according to reasons that are justifiable to them (as we in turn would expect from them) (Scanlon 1998, Kumar 2009). Contemporary freedom-based approaches challenge or supplement contract-based concepts from radically different political perspectives. Nozick's libertarianism (1974) argues for the minimal state, seeing even taxation as an injustice to be minimized. Sen's capabilities approach (1993, 1999, 2009) rather sees the state (and communities) as essential in providing the freedom to choose lives we value, by providing equal or sufficient access to education, health care and social welfare. Young (1990) also focuses on freedom - albeit expressed as a rejection of the 'distributional paradigm' in favor of a focus on justice understood as the removal of oppression and domination. For Young, freedom can be understood as affirmation of difference and inclusion in public life. Whether strongly based in ideas of freedom, or in social contracts, these moral theories are almost all primarily located within the dominant social imaginary of autonomous individual liberal subjects (Groves 2014).

So too are most approaches to procedural justice. The scope and definitions of procedural justice are varied, but common themes include consistency of treatment (or non-discrimination), impartiality (of decision-makers), voice (or representation for those affected) and transparency (of procedures) in ways that make decision makers accountable to other stakeholders (McLaren 2012b). Common expressions of procedural justice include human rights frameworks, ideas of equality of opportunity, and the 'Århus principles' of transparency, participation and access to justice with respect to decision-making. All these treat individuals as autonomous subjects, and typically seek to avoid constraints on individual freedom or agency. They also typically constitute individual subjects as equivalent regardless of differences in history, inheritance, vulnerability, and other factors that might restrict agency. Capability approaches begin to challenge this framing, with the implication that uneven capabilities might demand affirmative action to deliver procedural equality. But for the most part liberal procedural justice seeks impartiality and equal treatment regardless of other factors.

Stumpf et al (2015) seek to systematize conceptions and theories of justice: suggesting there are six key dimensions on which conceptions differ, and which can be applied to the

distributive, procedural, corrective and structural domains of justice. By structural they mean the background conditions, norms and institutions of a community (which form critical parts of social imaginaries). The six dimensions are: the community of justice and how it is formed or delimited in space and time; the claims of justice - which sort of claims are valid, and on what are they based; the *judicandum*, or the object of justice: what it is that is assessed as just or unjust, such as actions, persons, rules or states of affairs; the informational base or 'currency' in which claims are measured, such as capabilities, primary goods or money; the instruments of justice – the mechanisms through which a valid claim might be made good; and finally the principle(s) on which justice is to be assessed and outcomes sought.

In considering principles, Young (1990) offers equality, priority, or proportionality (in the last, just outcomes might be seen as proportional either to need or to desert). Rawls is strongly prioritarian – while not endorsing perfect distributional equality, he emphasizes the position of the worst off. Others have added sufficiency – giving highest priority to the needs of those below a particular threshold (e.g. Nussbaum 2006; Page 2007). In other spheres, scholars continue to debate the relative merits of egalitarian and utilitarian principles, particularly on a global scale where the extent of culpability of rich nations for global poverty is especially contentious (Pogge, 2010, Caney 2010a, Blake and Smith 2015, Armstrong 2012).

So far, this section has highlighted cultural variation in approaches to justice, and the range of different theories and conceptions that remain even with the dominant western liberal school and the associated social imaginary. In most cases philosophers seek to demonstrate the correctness of their particular approach to crafting a potentially universal theory. Yet there is an alternative response to diversity of justice theory and claims, which is to accept, and even welcome pluralism.

Pluralism in justice

Gardiner (2011) suggests that in considering climate justice, issues of procedural, distributional, and corrective justice are all relevant across multiple domains: domestic, international, intergenerational, environmental and ecological. Young (1990) argues that a plural understanding is potentially even more relevant in international domains than domestic ones, in that redistribution alone cannot hope to rectify institutionalized and inherited oppression and domination. In the broader discipline of environmental justice, conceptions of justice are explicitly plural but also predominantly pragmatic: empirically

derived from the demands and sensibilities of activists and movements (Walker 2012). A 'trivalent' concept of justice in which distribution, participation (procedural) and recognition are all understood as significant (Schlosberg, 2007) is widely applied in the literature, with more recent scholarship also often drawing on capabilities approaches (e.g. Schlosberg 2012).

The capabilities approach to justice (Sen 1993, 2001; 2009, Nussbaum 2000, 2006) is rich and complex, and hard to summarize briefly. In essence it sees justice as freedom to live lives that we value, underpinned by the capabilities to understand, evaluate and make those choices (encompassing factors such as good health, freedom from discrimination, and the ability to make emotional attachments, amongst others. Holland (2008) for instance stresses the significance of a supportive environment). It is invaluable in breaking some of the boundaries of more conventional moral philosophy, notably because it problematizes the subject of justice, and because it provides a richer understanding of what needs to be defended and distributed fairly. Nonetheless it is typically deployed very individualistically, even though logically, it encompasses collective or community capabilities as well as individual ones. Moreover, especially in Nussbaum's applications – using a defined list of capabilities – it can appear a form of liberal paternalism. On the other hand, Sen insists that people themselves must play a role in defining what they see as essential capabilities, through deliberation, and even in the list form, ideas of capabilities help define what full participation in society might mean, and help us see how underlying opportunities are shaped through past relations (individual and social).

Situated Justice

I argue that history, culture and moral philosophy all support the view that a plural approach is appropriate. History reveals that both our conceptions of justice, and the conditions in which it is contested change over time (Malik 2014). There is no reason to assume this process has stopped, and that we have achieved a transcendental, universal, ahistoric understanding of justice. Culture reveals continuing variations in justice conceptions (e.g. as shown in Henrich et al 2010), as well as some convergence around particular principles or considerations. And moral philosophy continues to offer healthy contestation and debate over the understanding and application of ideas of justice, despite frequent efforts and claims to universal application. Also as Young (1990) and Sen (2009) point out in different terms, the universal theories of moral philosophy are necessarily disconnected from the situated injustice of real life, and in their abstraction lose practical applicability. Moreover, all three aspects (history, culture and philosophy) feature in the descriptions of social

imaginaries set out above. In other words justice is (at least to some extent) contingent and situated within the extant social imaginary. However, as the quest for universal understandings suggests, justice is amongst the concepts with the potential to transcend social imaginaries, and indeed – if understood as including the fair distribution of power – it also has potential to transform social imaginaries (as understandings of what is a fair distribution of power change). As I argue later (Section 5.4) there is a close relationship between justice and politics, with practical and discursive contests over fair inclusion shaping the ground for politics at multiple levels (Ingram 2006; McNay 2008).

The most genuinely universal approaches are - perhaps ironically – the very ones that acknowledge difference and contingency in their starting points, and encourage deliberation over what is equitable, fair or just in a particular context: such as Sen and Nussbaum's capabilities approach, Sandel's version of virtue and the common good, and ideas of recognition expounded by scholars such as Honneth, Fraser and Young. The social imaginary-based critique of universalist (and atemporal) moral philosophies based in autonomous individuals does not even mean rejecting all their arguments about what is fair and just or abandoning the quest for any universal principles. But it does highlight that justice too is at least partly a co-produced emergent concept with evolutionary and cultural roots (Ridley 1996, Malik 2014).

The environmental justice space in which claims of justice and injustice are produced and negotiated (within and across the boundaries of moral and political communities) (Walker 2012, Schlosberg 2007) is therefore adopted here as a pragmatic guide. I argue that it is of utility, whether we are asking ultimately what is fair and just; or merely more instrumentally, asking what might be contested as unfair and unjust. In this context it is essential to be reflexive as a researcher. Discursive (and material) power to establish and shape conceptions of justice (valid grounds, principles, judicanda etc.) and to set and police community boundaries is embedded – often unseen - in social imaginaries and social habitus; and should itself be revealed and subjected to assessments of justice.

Environmental justice can be seen as a form of pragmatic ethics, deriving values and principles in part from the discourses and behaviors of stakeholders and activists (Walker, 2012). As noted in Section 1.2, pragmatic ethics can be read from behaviors, practices, discourses or technological characteristics. Although it is inherently plural, such an approach does not necessarily reject a quest for universal or transcendent ethical values. Even though practical ethics are culturally co-evolved and technologically co-configured, people can and do seek to evaluate the ethics and norms expressed against principles derived from moral

philosophy (Sayer 2011). Such interactions between practice and moral theory contribute to the ongoing development of the latter as a product of culture, technology and collective reasoning (Malik 2014). In Chapter 5, I seek to identify one such universalist foundation in the inter-personal solidarity that lies at the heart of a political account of recognition.

The importance of recognition

For environmental justice scholars recognition is an essential complement to distribution and procedure (Schlosberg 2007). Recognition embodies pluralism in practice. It roots justice in the mutual recognition of, and respect for, individuals or groups as different parts of society. Non- or mis-recognition results in psychological harm or social exclusion. Recognition approaches (Young 1990, Fraser and Honneth 2003) embody a similar approach to freedom as Sen, and highlight the importance of the (cap)ability to participate in society for all, including groups facing discrimination on grounds of factors such as gender, disability, ethnicity or sexuality. The addition of recognition enriches the plurality of justice approaches. But recognition also challenges the rational individual subjectivity of the dominant imaginary in three ways. First, it is both more responsive to difference and more relational than other liberal approaches to justice. Individuals in recognition approaches are not flattened into one uniform variety of human, and they are affective as well as rational beings. Second it goes beyond rhetorical or legalistic expressions of equality for disadvantaged groups to consider the personal and collective struggles and institutional transformations needed to deliver justice (Fraser and Honneth 2003, Young 1990). And third, it places significant emphasis on vulnerability, the needs for situated care that creates, and the ways in which the factors creating vulnerability are often beyond the control of the individual or group affected. Vulnerability and lack of control is particularly relevant in arguments from justice for targeted climate adaptation support (Schlosberg, 2012).

Yet the plurality of environmental justice is still rather constrained by western liberal conceptions of distribution and procedure. And even recognition can be deployed within, rather than against the liberal social imaginary. It often comes across – even in the work of scholars such as Hourdequin (2016), or Fraser and Honneth (2003) - as a procedural extension of participation, a means to consensus building and redistribution, rather than one that enables disruption and dissensus (Velicu and Kaika 2015). Nonetheless, ideas of recognition do tend to qualify or reject the simplistic idea of the rational individual subject. But justice approaches which actively decenter the individual are less common. Communitarian ethical approaches emphasize the importance of maintaining the community and its values, but still tend to treat individuals as the principal subjects of

justice (Sandel 2009). Indigenous peoples' rights approaches tend to recognize the collective or community as a rights bearer, while – in some polities - even extending rights to natural entities such as rivers. Some restorative justice approaches recognize communities as stakeholders in justice alongside the individual victims and perpetrators of crime (see *Paper 5*). Relational approaches to justice such as the ethics of care (Held 2006, Tronto 1993, Groves 2014) and the African philosophy of Ubuntu (Gade 2013) place a deliberate focus on the relationships between persons (and their quality) rather than (or as well as) on the individuals involved.

As noted above (Section 2.3) justice theories based on the dominant conception of individual subjectivity are of questionable value for approaching intergenerational justice (Groves 2014). In particular, most such approaches struggle to understand coherently the potential harms experienced by future people whose very existence and identities depend on the social arrangements and activities that also brought about the apparent harm (the so-called non-identity problem described by Parfit (1983)). Many philosophers seek to elude the non-identity problem with non-person affecting ideas of harm (e.g. Heyward 2008). But I find richer responses in the prospect of care based approaches (Held 2007, Groves 2014) which imply a need to care for the existence, identity and conditions of life of future people simultaneously, and especially through establishing capabilities and autonomy for them to define and determine their own lives and values. There are also possibilities in the combination of recognitional with restorative or corrective approaches, which reverse the temporal bias implied in the non-identity problem, and these are discussed in more detail below (Section 5.3).

Agency and capacity

The identification of actors that can reasonably be held responsible for obligations of justice is not necessarily any simpler than identifying the victims of injustice. This challenge raises many questions (which have diverse answers from different moral perspectives). Here I mainly want to emphasize the need for some sort of concept of 'capacity' (as a measure of or condition on agency). In the same way as we would not ethically expect a non-swimmer to risk their life to try and save someone from drowning, nor hold a mentally ill person to the same standards of legal responsibility as a healthy one; in understanding and implementing justice there must be some means to ensure that duties are not imposed on individuals and

groups lacking the capabilities to fulfill them.[10] Baer et al (2008) interpret the idea of capacity in terms of an income level above which citizens are expected to contribute to emissions reductions, but below which their emissions are treated as essential. But there is a corollary question unanswered by this: whether the capacity to act itself generates an obligation to do so in a world of widespread injustice, and dispersed responsibility. Where direct culpability is hard to determine due to the aggregate nature of the causes of harm, due to difficulties in assessing intentionality, or where there are simultaneously ethically good and ethically bad effects from actions (all of which pertain with climate change (e.g. Caney 2010b, Heyward 2014, Morrow 2014a)), we cannot simply argue that the duty lies with the actor responsible for the harm. A more practical approach arises if we combine capacity (the ability to act to reverse, prevent or ameliorate the harmful act) with complicity (the circumstance of having benefited, even if only indirectly from the actions that led to the harm). In the climate case this might suggest that duties to mitigate and to fund adaptation would accrue to those actors able to deliver or fund such actions, and in proportion to the degree to which they had benefited from the past and current use of fossil fuels. As discussed in Foundation 3, power comes not only in direct forms, but also structural and co-produced forms (such as Foucault's *governmentality* or Bourdieu's *habitus*) in which discipline is self-imposed through discourse, norms or habits. While such forms of power dominate life choices and opportunities, they are not so amenable to analysis through the lens of moral philosophy to identify clear duties and duty bearers. On the other hand identifying capacity and complicity would seem plausible. Again in such an understanding, actors are perhaps better understood in terms of relations, networks and discourses. In this context recognition becomes if anything more important as a means of engaging with the subjects of justice. Whether individuals or networks or discourses, subjects in this context have a narrative form of identity which can be recognized. With that recognition we can at least theoretically identify victims and perpetrators of climate injustice.

(Plural) Justice in CGE

CGE scholarship has featured a strong focus on the generic ethics of climate engineering (Corner and Pidgeon 2010, Gardiner 2010 & 2011b, Hamilton 2013, Hulme 2014, Smith 2012, Preston 2012 & 2013, Burns and Strauss 2013), which has arguably accompanied the

[10] This also has the instrumental benefit of ensuring that duties do not go unfulfilled because of incapacity of the directly culpable, thus further harming those disadvantaged who would have materially benefited from fulfillment of the duty.

emerging technology from an earlier point and in greater detail than in analogous technological areas such as genetic modification. Yet in comparison to the broader climate literature, justice has not featured heavily (exceptions include Whyte 2012, Burns 2013, Preston 2013b & 2016). Moreover, as *Paper 2* outlines, the modeling literatures that structure CGE (and imagine the principal technologies: BECCS and SAI) presuppose a particular (narrow) consequentialist reading of justice (embedded in the dominant social imaginary). And, as *Paper 4* summarizes, the broader narratives and framings of CGE across the scientific and popular literature tend to frame out justice, especially in restorative or corrective terms (one might describe this as mis-recognition of the victims of climate injustice). This framing out effect extends even to discussion of climate restoration, which is presented in the literature (as discussed in *Paper 5*) as a technical, environmental task, with reference to abstract baselines (such as a time before human interference), rather than as a vehicle for restorative justice with affected human (and non-human) communities.

STS based approaches to technology and CGE have yet to fill this gap, although they help illuminate it. As Ottinger argues: "technocratic approaches to environmental policy, including quantitative risk assessment … exclude affected communities from decision-making, not necessarily in principle, but by structuring policy discourses so as to devalue their contributions" (2011: 81). Moreover, "technology is more than the substance of environmental injustice. Technologies and technological systems are also among the structures of injustice" (2011: 81). In other words technologies such as CGE help constitute the institutionalized misrecognition that Fraser (in Fraser and Honneth 2003) highlights as structural injustice, and that McNay (2008) sees in Bourdieuvian cultural habitus. Moreover, such technologies can also support systematic political injustice. Centralized and complex technologies tend to work against environmental justice (Stirling 2014, Ottinger 2011); and in the case of CGE the technologies tend to resist democratic governance, either through centralized and high leverage nature in the case of SRM (Szerszynski et al 2013, and *Paper 4*) or through their association with administrative depoliticized governance (such as carbon markets) in the case of CDR (*Paper 4*).

The plurality embodied in an environmental justice-centered concept of justice has several important consequences for the consideration of CGE. First, environmental justice perspectives, by examining the interests and politics behind injustices, highlight the utilitarian and consequentialist focus of CGE advocacy (and its embeddedness in particular socio-technical and economic imaginaries) (see *Paper 2*). Second, recognition of the actors, perspectives and values currently largely unrecognized in the CGE discourse helps expose

the ways CGE acts as a tool to sustain neo-liberal capitalist social arrangements and social imaginaries, notably by apparently offering a technocratic, post-political solution to the climate challenge (see *Paper 4*). Third, insofar as justice extends beyond conventional distributive and procedural dimensions, this permits integrated consideration of the restitutive / corrective dimension of climate justice (often overlooked in conventional analysis), which in turn highlights the significance of care (see *Paper 5*). Finally, environmental justice enjoins us as researchers to listen to the experience of victims, actors and activists, not just to help understand the content of injustice, but also to help define its dimensions and approaches. In this context it is illuminating that the deliberation reported in *Paper 3* (although very limited in scope and geography) already reveals the plurality of justice concepts amongst publics, even within the neo-liberal social imaginary.

2.7 Combining the foundations

The concepts and theories of social imaginaries, co-production of socio-technical systems and conditioned forms of agency and power provide an essential and complementary set of lenses with which to analyze, understand and normatively evaluate the justice implications (or fairness) of a particular socio-technical system (the emergent forms of CGE in this case). Figure 2.1 indicates how social imaginaries, co-production and conditioned agency interact to reproduce and reconfigure conceptions and principles of justice, which in turn influence the physical expressions of each of the former concepts. In the iterative research process I first introduced the theories of co-production to illuminate the relationship between technology and justice. This highlighted the limited concepts of agency and normativity in STS, and led to my consideration of more complex theories of subjectivity, power and agency from sociology. The addition of the concept of the social imaginary allowed me to conceptualize better how socio-technical systems can be shaped by, and reshape, underlying concepts of identity, subjectivity and agency, and to understand the pervasiveness of particular epistemological and ontological assumptions.

The chapter has suggested an understanding of subjectivity and agency as conditioned by the extant social imaginaries and by co-produced socio-technical systems. Not only is there sufficient scope for human subjects to influence the system for them to be held normatively accountable for their actions, the extent of agency (or freedom) available to humans offers one direct measure of justice. In later chapters (4 & 5) I examine the ways in which CGE technologies as emerging socio-technical systems within the dominant social imaginary might enhance or constrain such justice as agency.

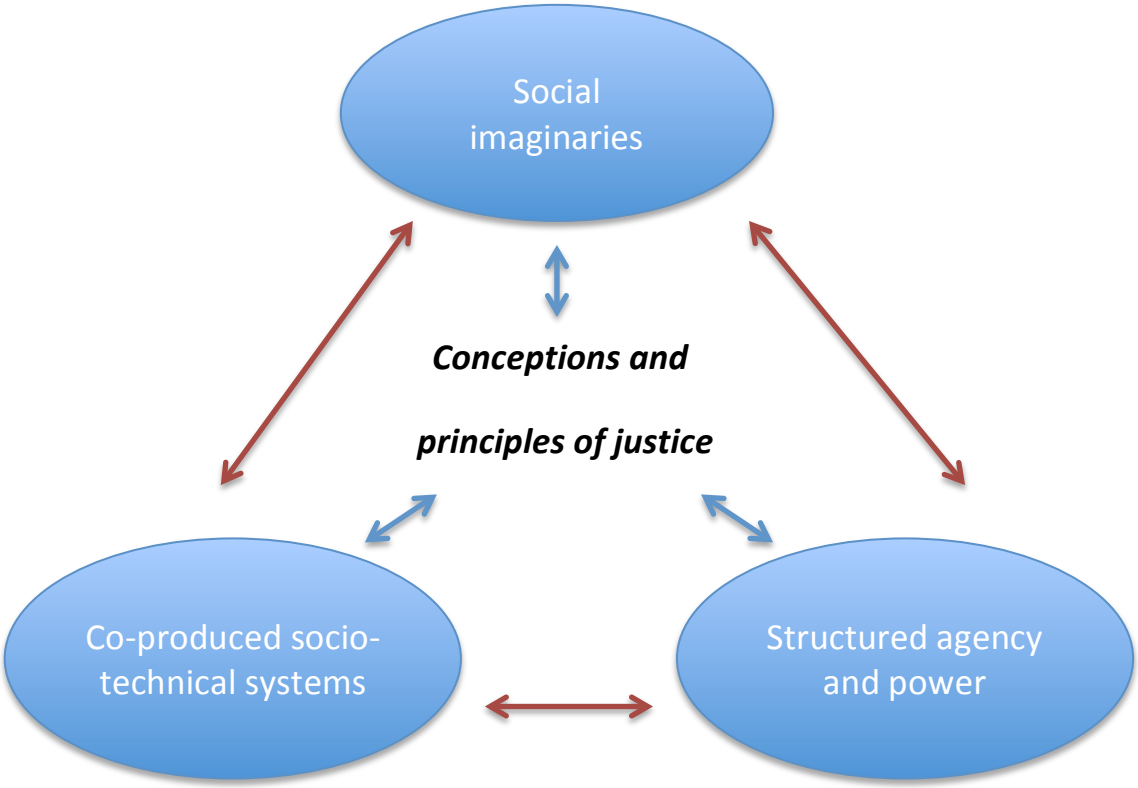

Figure 2.1: The relationships between society, technology, power and justice

The introductions to the papers in the next chapter also indicate the relevant linkages suggested here. But before turning to the papers I want to conclude this chapter by noting that the approach set out here transcends three pervasive dualisms in contemporary thought. First, it rejects the dualism of analytical and normative thought (highlighted by Sayer, 2011), arguing instead that normative evaluation is possible as long as the mechanisms structuring the co-production of our conceptions of justice are reflexively exposed to the same process of evaluation. Second, as discussed also in section 1.4, it rejects the dualism of constructivist and realist ontologies, arguing rather for a constrained and structured or co-productive form of constructivism. Finally it also rejects the dualism between free-will and determinism, in favor of, once again, a conditioned and constrained form of agency which is a characteristic not only of human individuals, but of relationships, networks and collectivities of human and non-human subjects.

Chapter 3: The five papers

The five papers presented in this chapter record a series of engagements with the overall topic from a variety of perspectives (as outlined in Chapter 2), applying diverse methods (as described in Chapter 1). In turn the process of research and writing of these papers has triggered or enabled a range of learnings. The most directly relevant of these are highlighted below alongside a brief introductory summary of each paper.

Paper 1: Mitigation deterrence and the 'moral hazard' in solar radiation management

Paper 1 was written in response to a call from Earth's Future journal for reflections on the 10 years of research into solar geoengineering following Paul Crutzen's editorial in Climatic Change in 2006, which arguably broke something of a taboo against such research which had been sustained by fear of a 'moral hazard' effect in which consideration of solar geoengineering might undermine commitment to other – more desirable or plausible - forms of action on climate change.

Paper 1 reviews and explores the ways researchers have debated the significance and relevance of this concern from multiple disciplines and perspectives. It highlights the significance of policy goals and the actual and perceived substitutability of SRM for mitigation. It notes continuing problems in detecting mitigation deterrence in practice. It distinguishes different forms of moral hazard effect, and considers the plausibility of the opposite effect, of mitigation galvanization. It predicts that attention will turn to the situated, contingent expressions of mitigation deterrence and mitigation galvanization amongst different actors and at different scales; and to more sophisticated practical means to minimize the incidence and impacts of mitigation deterrence.

The paper locates the threat (and moral concern) of mitigation deterrence by climate engineering in a common but problematic definition of climate change as an issue of 'climate risk' rather than one of climate justice, arguing that the latter sees more purposes and motivations for mitigation than purely reducing climate risk, and that it is the loss of these (especially those relating to justice) that would remain problematic even if climate geoengineering can substitute directly for mitigation as a means of reducing climate risk. A focus on climate risk also constitutes the climate problem as a technocratic one, rather than a political one; and helps frame humanity as a single group simultaneously responsible for the threat of climate change, and all affected by it; rather than drawing attention to the

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Crutzen +10: Reflecting upon 10 years of geoengineering research

Mitigation deterrence and the "moral hazard" of solar radiation management

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Abstract Fears of a moral hazard effect deterring mitigation have dogged solar radiation management (SRM) research since before 2006. Researchers have debated the significance and relevance of this concern from multiple disciplines and perspectives. This article explores this debate, highlighting the significance of policy goals and the actual and perceived substitutability of SRM for mitigation. The continuing problems in detecting mitigation deterrence in practice are noted. Different forms of moral hazard effect are distinguished, and the plausibility of mitigation galvanization considered. It is predicted that attention will turn to the situated, contingent expressions of mitigation deterrence and mitigation galvanization among different actors and at different scales; and to more sophisticated practical means to minimize the incidence and impacts of mitigation deterrence.

Key Points:
- The relevance of mitigation deterrence depends critically on the assumed goals of climate policy
- The greater the divergence between perceived and actual substitutability of SRM for mitigation the more significant the hazard
- More effective responses are needed in SRM research governance as well as in deployment governance

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1. Introduction

"Given the grossly disappointing international political response to the required greenhouse gas emissions, research on the feasibility and environmental consequences of climate engineering, which might need to be deployed in future, should not be tabooed. [*Crutzen*, 2006: p. 214]"

"Importantly, its possibility should not be used to justify inadequate climate policies, but merely create a possibility to combat potentially drastic climate heating. [*Crutzen*, 2006: p. 216]"

In 2006 Paul Crutzen challenged the tacit taboo on public academic discussion of solar radiation management (SRM). He argued that the continued inadequacy of climate mitigation meant that, regardless of the risks involved, SRM should be seriously considered. In doing so, he recognized that fear of a deterrent or delaying effect on mitigation had underpinned previous scientific reticence. Such potential effects were also noted in various ways in many of the commentaries published alongside Crutzen's editorial [*Cicerone*, 2006; *Lawrence*, 2006; *MacCracken*, 2006].

Since then, the fear of a deterrent effect on mitigation has been a persistent bone of contention in the SRM literature—often described as a moral hazard (following *Keith*, 2000), echoing economists' explanations of why "too-big to fail" banks happily took excessive risks with other people's money, to the extent of triggering global financial crisis. In climate engineering, the "moral hazard" is that decision makers may reduce mitigation effort, believing climate engineering to represent adequate insurance against climate risk. Theoretical and philosophical speculation to this end has been superseded by much more detailed and disaggregated analysis of potential forms and effects of moral hazard (e.g., *Hale*, 2012), and by empirical testing of some forms in both public deliberation and psychological experiments.

The problem has been examined from many perspectives, with arguments and evidence presented and challenged for both mitigation deterrence and mitigation galvanization in response to increased knowledge about climate engineering [*Morrow*, 2014; *Moreno-Cruz*, 2015; *Merk et al.*, 2016]. While contemporary economists tend to define moral hazard narrowly as a problem of insurance, climate engineering scholars concerned about mitigation deterrence have suggested and explored a wide range of other analogues from seatbelts to sexual health. Some have argued that moral hazard is of limited relevance, or at least inappropriate terminology [*Bunzl*, 2009; *Royal Society*, 2009; *Hale*, 2012; *Keith*, 2013; *Reynolds*, 2014], but others continue to suggest concerns [*Gardiner*, 2011a; *Lin*, 2013; *Baatz*, 2016].

And even within economics, the narrow definition of moral hazard is contested. Here I apply a fairly broad definition of moral hazard, following the economist Krugman [2009: p. 63], of "any situation in which one person makes the decision about how much risk to take, while someone else bears the cost if things go

badly." This does not limit the moral hazard problem to insurance and its analogues, nor to circumstances in which the transfer of risk is consensual, but information asymmetric (the classic form of moral hazard in insurance). Rather, the central concern is that current decision makers who might choose to delay or reduce mitigation in response to the prospect of SRM are determining the risks faced by those most vulnerable to climate risks now and in future generations.

The broad definition also allows for the possibility that SRM might deter other desirable aspects of climate policy, not just mitigation per se. Also it encompasses diverse variations and mechanisms suggested by climate scholars including: moral corruption—our susceptibility to self-serving temptation, where those to whom we owe moral duties are remote in space and time [*Gardiner,* 2011a]; risk compensation or adaptation—that we psychologically adapt our behaviors to maintain a broadly constant level of risk [*Keith,* 2013; *Lin,* 2013]; mitigation obstruction [*Morrow,* 2014]; and substitution [*Reynolds,* 2014] or "trade-off" [*Baatz,* 2016]. It also embraces the justice dimension of moral hazard in the transfer of risk as well as the prospect of suboptimal welfare outcomes.

In the remainder of the article, I review this literature, highlighting the significance of different assumptions about policy goals and substitutability (Section 2), the challenges of disaggregation and detection (Section 3) and possible measures to ameliorate the problem (Section 4). Section 5 offers some brief conclusions and speculation on future developments.

2. Policy Goals and Substitutability

The literature highlights the significance of two interrelated underlying questions. First, what is the goal of climate policy? Second, to what extent could SRM substitute for mitigation in delivering that goal?

If SRM substituted perfectly for mitigation (i.e., could deliver the same outcomes, with no undesirable side effects) then there would be no particular reason to worry about moral hazard [*Hale,* 2012]. Indeed, if as some advocates suggest, SRM would be cheaper and faster than mitigation, then from such a perspective it appears desirable. On the other hand, if SRM could not substitute for mitigation at all, there would be no incentive to adopt it, and thus also no reason to worry about moral hazard. Of practical concern, however, is the messy space between these extremes, where SRM and mitigation are imperfect substitutes for one another across a range of dimensions, and where the goal is critical.

The more narrowly defined the goal of climate policy, the easier it can be for SRM to appear a decent substitute. Indeed, if the goal was simply to constrain global average temperature rise, then SRM potentially becomes better than a perfect substitute, as mitigation—however rapidly achieved—cannot avoid some further temperature increase. But, as *Baatz* [2016] highlights, the prospect of a harmful termination effect if SRM were to be deployed and then halted without complementary mitigation, also makes the two highly imperfect substitutes with respect to climate risk. Also with broader goals for climate policy, SRM's substitutability becomes worse. Even focusing only on temperature, SRM's global effect would not deliver the same latitudinal pattern of temperatures as a similar global average resulting from mitigation [*Lunt et al.,* 2008]. Going beyond temperature, and considering precipitation and the hydrological cycle, SRM appears even worse: that is, it is likely to overcompensate in at least some regions for the precipitation impacts of rising CO_2 concentrations, if deployed so as to compensate for the global temperature effects [*Moreno-Cruz et al.* 2012]. Moreover, even the apparent advantage of SRM in speed of effect becomes an exacerbating factor in moral hazard, as any delay to mitigation increases the scale of those committed impacts of future warming—such as ocean acidification—that are not prevented by SRM at all. In general, the greater the divergence between the *perceived* and *actual* substitutability of SRM and mitigation, the greater the harms that mitigation deterrence would cause.

Nonetheless *Reynolds* [2014] argues that assuming a goal of reducing climate risk, a marginal substitution of SRM for mitigation could be unproblematic (indeed even rational, at least in optimal circumstances). *Keith* [2013] similarly argues for a "rational" degree of risk adjustment: that as SRM would reduce overall climate risk, reduced mitigation effort would be rational. But climate policy has broader objectives still, because of the extent to which the issue is entangled with questions of economic progress, social justice, and international development. From a utilitarian perspective substitution may appear neutral and rational; but if climate change is understood as a product of unrestrained market capitalism [e.g., *Klein,* 2014] substitution is just another expression of the problem. As a cheaper policy option, SRM might free up economic resources

that would otherwise be diverted to mitigation, but such an approach would also forego economic opportunities in ecological modernization, and social benefits arising from the adoption of desirable new behaviors and values. Moreover, if the goal is climate justice, mitigation—following principles of common but differentiated responsibility—not only acts to reduce risk, and enhance intra- and inter-generational justice, but also as a form of corrective justice, penalizing high-emitting countries and corporations most. If mitigation is deterred all these goals suffer.

Neither game theory nor economic modeling has convincingly dismissed the problem of mitigation deterrence. *Goeschl et al.* [2013] develop a simple inter-generational game-theory model, in which they find mitigation deterrence plausible but rational, rejecting therefore the "moral hazard" label. They also find a possible equilibrium solution, where there is increased mitigation in the presence of SRM. This implies a possible galvanization effect, albeit based on rather impractical assumptions (that fears of the *future* side effects of SRM would lead *current* generations to enhance mitigation efforts). *Moreno-Cruz* [2015] similarly argues in an international context that although plausible free-rider effects may reduce mitigation, the fear of SRM might stimulate other countries to increase mitigation effort. This echoes the experience of the German *Energiewende*, in which greater efforts to develop renewable energy have accompanied rejection of nuclear power [*Lawrence et al.*, 2016]. But for such outcomes to outweigh free-rider effects globally, those countries galvanized by fear of SRM must also have combined mitigation potential of global significance and no alternative route to minimize the negative effects of SRM [*Baatz*, 2016]. In practice, neither assumption seems plausible.

Moreover, the practical implications of arguments of those (like *Reynolds*, 2014) who portray reduced mitigation as potentially rational risk adjustment are problematic. This applies only in an abstract and unrealistic situation of optimal mitigation. In other words, for it to be rational to reduce mitigation in response to the addition of SRM, mitigation would already have to be at a rational level. Yet that is patently false (except perhaps from the perspective of climate deniers). Indeed, a common rhetorical device of SRM research advocates to claim rather that mitigation is so inadequate that SRM research could not possibly further reduce it (e.g., *Keith*, 2013). In reality, the irrationally low level of mitigation both highlights the importance of avoiding further incentives for delay and arguably exposes the existing vulnerability of our decision makers to moral corruption and moral hazard, exacerbated by climate denial, vested interests, and collective action problems [*Gardiner*, 2011a, 2011b; *Lin*, 2013].

Recognizing that some climate deniers are motivated by a desire to prevent mitigation highlights a particular mechanism of the moral hazard effect that deniers might adopt SRM advocacy as a political device [*Lin*, 2013], to protect vested interests [*Stirling*, 2014], and thus execute the "Super-Freak pivot" from climate denial to SRM advocacy [*Morton*, 2015]. Such fears are supported by evidence that climate skeptics are more likely to support action on climate change when given information about SRM [*Kahan et al.*, 2013]. Kahan et al.'s analysis implies a galvanization effect for this group, but effectively presumes the goal is to achieve "concern about climate change" [*Lin*, 2013] rather than reducing climate risk, delivering mitigation or climate justice. This particular "political" expression of moral hazard highlights the importance of considering different expressions of the problem.

3. Disaggregating and Detecting Moral Hazard

Despite predominant attention to universal effects, some commentators have begun to disaggregate moral hazards into various forms [*Hale*, 2012; *Corner and Pidgeon*, 2014; *Reynolds*, 2014], recognizing that the mechanisms and outcomes might be different in different contexts and for different actors. Here I apply the categorization suggested by *Corner and Pidgeon* [2014], distinguishing an individual hazard (that the prospect of climate engineering will reduce individual commitment to mitigation and change behavior), a social hazard (that the prospect will influence social norms and discourses, and resulting behaviors), and a political hazard (that the prospect will influence the decisions of powerful actors such as corporations and politicians).

This distinction is particularly valuable as it contrasts social and political effects with individual ones. Yet it is at the individual level where the majority of empirical indications of any galvanizing impact have been found [*Royal Society*, 2009; *Mercer et al.*, 2011; *Corner and Pidgeon*, 2014; *Merk et al.*, 2016]. This empirical literature also hints at significant cultural and national variation [as found in public opinion

on SRM by *Sugiyama et al.,* 2016]. The strongest evidence for a galvanizing effect comes from *Merk et al.'s* [2016] study in Germany. Here, however, fears of nuclear power have previously stimulated strong mitigation action, but have not prevented commitment to nuclear power in other polities, with more limited renewable development [*Lawrence et al.,* 2016]. Merk *et al.'s* study perhaps confirms that where SRM is seen as a high risk, exceptional policy is unlikely to trigger moral hazard, at least at the individual level; but this says little about how it might impact if normalized in the policy mix. Elsewhere the evidence for galvanization appears circumstantial and has been questioned (e.g., by *Lin,* 2013 and *McLaren et al.,* 2016).

German energy policy suggests a practical analogy for galvanization at a political level. The work of *Goeschl et al.* [2013] and *Moreno-Cruz* [2015] cited above finds theoretical possibilities of such political galvanization by SRM, but also of deterrence in the form of political free-riding. *Manoussi and Xepapadeas* [2013, 2014] combine game theory and economic modeling to conclude that free-riding effects would lead to substitution of climate engineering for mitigation in both cooperative and noncooperative situations, regardless of whether countries face symmetric or asymmetric social costs from climate impacts. Several commentators have highlighted the prospects of a political form of moral hazard in which policy makers happily defer costly or politically challenging decisions on mitigation [*Burns,* 2011; *Lin,* 2013; *Corner and Pidgeon,* 2014]. Insofar as conflict and disagreement might arise over climate engineering proposals [*Morton,* 2015], this could also act to slow mitigation by undermining the trust and cooperation needed to progress international climate agreements.

Public engagement findings confirm that publics already fear the existence of social and political forms of moral hazard arising from SRM (e.g., *Wibeck et al.,* 2015). Moreover, such work suggests a tendency to attribute vulnerability to moral hazard to "others." This does not refute the individual moral hazard thesis, as admitting to deviant behavior in heterogeneous focus groups is unusual. On the other hand, it would seem to strengthen the thesis that a social mechanism of behavioral norms could reduce mitigation in the presence of SRM. A potential social hazard may also be exacerbated by common cognitive biases and heuristics [*Lin,* 2013]. Cognitive biases also seem to contribute to the psychological and cultural risk-redistributing effects of technologies such as seat belts and guns [*McLaren,* 2015]. Discursive framings in research and public media which present SRM as an alternative or substitute for mitigation may also stimulate a social form of moral hazard, for example, by contrasting SRM with unabated climate change or prematurely presenting it as practical and controllable [*Morrow,* 2014; *McLaren,* 2016].

Establishing the reality and extent of such social and political hazards is difficult, although theoretical work largely endorses the possibility [*Gardiner,* 2011a, 2011b, 2013; *Lin,* 2013; *Baatz,* 2016]. *Gardiner* [2013] stresses that the social and discursive nature of such risks maintains a hazard even if scientists are pursuing SRM research in good faith [*Preston,* 2013a]. A major problem, especially for demonstrating social and political forms of moral hazard, is the absence of a counterfactual. Many commentators [e.g., *Hale,* 2012; *Gardiner,* 2013; *Preston,* 2013b] stress the difficulties in detecting moral impacts in ex-ante studies, and the continuing importance of theory in this respect. However, even ex-post, the lack of a counterfactual makes interpretation difficult. *Reynolds* [2014] concludes that growing attention to adaptation did not deter mitigation, while *Lin* [2013]—on the same evidence base—suggests it may have.

Detecting social or political moral hazard arising from elevated consideration of SRM is just as challenging. A substantial upturn in SRM research and publishing has occurred since Crutzen's editorial. *Preston* [2013a] (like *Reynolds,* 2014) argues that this climate engineering research has not depressed mitigation talk; but the reality remains that mitigation action is patchy, contingent, and in aggregate severely inadequate. The decade has been marked by substantial emissions growth and relative inaction in global climate mitigation, with a major failure in international negotiations in Copenhagen in 2009. Also more recent progress, marked by the Paris Accord of 2015, has shifted policy attention to temperature targets (without associated emissions targets): a change that opens a very large opportunity/loophole for SRM advocacy. While there are many other reasons for slow progress on mitigation—from vested interests to collective action problems—we cannot definitively rule out a contribution from moral hazard around climate engineering. Moreover, given the glacial rate of progress hitherto on mitigation, the simple risk of mitigation deterrence must motivate us to find ways to counteract it.

4. Responses and Solutions?

Finally, I summarize some suggestions that have already been presented as means to minimize or manage the risk of mitigation deterrent or moral hazard. These typically seek to prevent substitution effects, either through changing research practices and communication [*Banerjee,* 2011; *Lin,* 2013; *Morrow,* 2014], or by proposing governance mechanisms that would more strongly tie SRM deployment to effective mitigation [*Parson and Ernst*, 2012; *Lin,* 2013; *Preston,* 2013a].

Morrow [2014] urges researchers to include relevant alternatives in their modeling and analysis; to adopt careful messaging (and framing) that avoids over-optimistic interpretation and presentation; and to engage directly with publics and policy makers to minimize the impacts of media distortions. Early public engagement to help shape research might also be beneficial. *Lin* [2013] also advocates framing and outreach that does not exaggerate the potential of SRM, and makes clear that it is at best a temporary palliative. Taken in isolation, none of these seem likely to prevent mitigation deterrence, but may help us identify where it is most likely to appear.

Preston [2013a] suggests requiring governance mechanisms for the cessation of SRM as a condition on deployment, as a means to incentivize mitigation so as to avoid termination effects. *Parson and Ernst* [2012] suggest that only countries with a good record on mitigation should get to participate in setting rules for SRM deployment. *Lin* [2013] seeks lessons from insurance underwriting, and suggests setting preconditions for SRM deployment (including mitigation commitments), and independent oversight. Such approaches may help, but rely on the incentives to free-ride being weak, and assume more stringent governance mechanisms than seen so far in climate policy. Thus such proposals seem unlikely to be decisive in influencing the decision makers most vulnerable to moral hazard.

The proposals focused on governance acknowledge that without intervention, SRM's apparent attractions could undermine mitigation, but treat research findings as independent and objective. In contrast, those proposals focused on communication and framings tend to seek to reduce the risk that SRM may be misperceived as a better substitute than it would be in practice, and engage more closely with research methods. In this they better understand research as part of the processes through which sociotechnical systems are shaped, rather than treating notional SRM technologies simply as objects to be governed [*Stilgoe,* 2015].

5. Conclusions

We have seen that different interpretations of the mitigation deterrence issue reflect differences in emphasis on the various objectives of climate policy. They also reflect differences in understanding of the causes of the climate policy logjam. In a collective action problem, moral hazard looks different than in a vested interest problem. Such differences in objectives and understanding are not simple to resolve—there is no single rational or benevolent actor dictating climate policy. What seems almost certain is that some actors—potentially including some states—will experience an incentive to reduce or defer mitigation in the presence of SRM, while others do not. We might begin to try to answer such questions with detailed cross-cultural and international comparative studies, drawing on past experience with politically contentious emerging technologies such as carbon capture and storage, and applying relevant theoretical frameworks from cultural political economy [*Tyfield,* 2012] and science and technology studies, such as the sociology of expectations [*Borup et al.,* 2006].

That SRM might help manage climate risk over certain timescales is not a reason to ignore the impact of any deterrent effect on mitigation on those or other timescales or on broader climate policy goals such as climate justice. On the other hand, these plausible deterrent effects alone are inadequate to rule out good-faith research, but should stimulate responsible innovation practices and good governance of SRM research too. Such approaches are likely to feature much greater reflexivity, public involvement, and democratization of SRM research, recognizing the dangers of scientific hubris and the limitations of expertise.

The idea of an all-or-nothing moral hazard or mitigation deterrent that either should prevent SRM research or can be safely ignored is therefore unhelpful. The next decade of research will need to turn from trying to prove or disprove the phenomenon of moral hazard, to much more nuanced efforts to understand when, where, and how it might appear; the extent of the likely negative impacts on climate policy and its goals,

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including that of climate justice; and the effectiveness of different mechanisms to limit or even reverse those impacts.

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Paper 2: Whose climate? And whose 'justice'? Conceptions of justice in solar engineering modeling

Paper 2 explores the role of underlying assumptions about justice in the construction of climate engineering knowledge. While based on a review of climate modeling studies focused on one potential CGE technology, stratospheric aerosol injection, much of its analysis is generally applicable to CGE. Taken together, the models suggest that SRM technologies would create distinctively new climates, closer to present climate than those resulting from unabated emissions; but with different winners and losers. The paper exposes embedded presuppositions about the nature and practice of modeling, alongside unexplored and narrow utilitarian and distributional conceptions of justice. It considers the implications of these underlying assumptions and values for the discourses of climate engineering, and argues that they not only obscure the identification and consideration of a range of potential injustices arising in the pursuit of climate engineering; but also create and reproduce asymmetries in power regarding the discourses and evaluations of climate engineering prospects. The paper offers some suggestions to improve the design, deployment and interpretation of climate engineering models to mitigate these problems. It also suggests that plural and relational concepts of justice could more generally be deployed to enrich understanding of the political dynamics of science and technology and the appraisal of emerging technologies.

Paper 2 suggests that even though climate engineering modelers sometimes broaden the understanding of the goals of climate policy to questions of risk distribution they tend to deploy a risk-analysis imaginary which imposes culturally, politically and ideologically narrow constructions of justice on the debate. These constructions are often utilitarian, and typically consequentialist, applied in a forward looking predictive mode which tends to ignore inherited, situated injustice and vulnerability to climate risks; and the implications of uncertainty for vulnerability. Modeling practices exacerbate these concerns, in particular by the consistent use of counterfactuals rooted in business as usual scenarios, rather than those involving elevated or accelerated mitigation. At the same time, the paper illustrates the ways in which knowledge about CGE is constructed in risk-managerial forms through modeling (assuming away uncertainties in the models, in the (as-yet imaginary) technologies of CGE and in the monitoring and control tools that would link them in deployment). Moreover, at the same time the modeling co-creates the technological imaginaries of CGE, privileging technoscientific epistemologies in the understanding of climate change and CGE.

The version reproduced below was submitted to Energy Research and Social Science. Between submission of the thesis and the viva, an invitation to 'resubmit subject to revisions' was received. The reviewers suggested a need for greater detail and clarity in setting out the methodology, both in terms of the selection of literature, and the practice of analysis; making clearer the connections between the modeling literature and the representations of justice identified therein. The reviews also encouraged greater acknowledgement of the limitations of the methodology and noted the desirability of supplementing this approach with qualitative interviews (clearly impractical at this point). I intend to make such revisions and resubmit. One reviewer also suggested a less ambitious approach to justice, focusing on the contrast between distributional and procedural approaches. However, rather than taking this route, I propose to highlight the differences between forms of justice compatible with the dominant social imaginary (found in the literature), and those which would challenge it (largely absent from the literature).

Whose climate? And whose 'justice'? Conceptions of justice in solar geoengineering modelling

Abstract

The role of underlying assumptions about justice in the construction of climate geoengineering knowledge is explored, based on a review of climate modeling studies focused on stratospheric aerosol injection. Such emerging technologies would create distinctively new climates, closer to present climate than those resulting from unabated emissions; but with different winners and losers, in part as a result of implications for energy systems. Embedded presuppositions about the nature and practice of modeling are exposed, as are unexplored and narrow utilitarian and distributional conceptions of justice. The implications of these underlying assumptions and values for the discourses of climate geoengineering are considered. It is argued that they obscure the identification and consideration of a range of potential injustices arising in the pursuit of climate geoengineering; and create and reproduce asymmetries in power regarding the discourses and evaluations of climate geoengineering prospects. In particular, optimistic climate geoengineering discourses risk sustaining the elite interests in high-carbon energy economies. Some suggestions are offered to improve the design, deployment and interpretation of climate engineering models in trans-disciplinary research so as to mitigate these problems.

Introduction

Climate geoengineering is increasingly debated as a response to the problems of climate change and excess carbon emissions from energy systems. In various forms it appears to offer a technical fix that may well deter or delay the transition to clean energy (Markusson et al 2017, Wibeck et al 2015, McLaren 2016a&b). In this paper I explore ways in which underlying utilitarian presuppositions about justice, expressed in climate modelling practices and results, contribute to misleading discursive framings of technological optimism regarding the dominant form of solar climate geoengineering: stratospheric aerosol injection. In turn these framings risk a moral hazard effect in which geoengineering substitutes for mitigation, thus sustaining other negative impacts and injustices of fossil fuel extraction and use.

Climate geoengineering techniques are typically divided into carbon dioxide reduction (CDR) and solar radiation management (SRM). CDR involves removing greenhouse gases from the atmosphere, and, as a technical fix, promises future recovery of current emissions. CDR is not considered further here, but is already embedded in climate pathways models as a means to make carbon budgets add up to meet particular temperature targets (Fuss et al, 2014; Anderson 2015). SRM reduces the proportion of the sun's heat captured in the earth system, typically by reflecting more sunlight. Stratospheric aerosol injection (SAI), which dominates the geoengineering literature (Linnér and Wibeck, 2015), would reflect sunlight by dispersing small particulates into the stratosphere using aircraft, artillery or a balloon-lofted pipe, and thus reducing global temperatures through the same basic mechanism as occurs with large volcanic eruptions. Fundamental physical differences between the climate forcing mechanisms of

greenhouse gases and sunlight reflection mean that such interventions would create distinctively new climates, rather than restoring historically familiar ones.

Although such interventions are yet little more than technological imaginaries and their future evolution as co-constitutive parts of socio-technical systems largely unknowable (Stilgoe, 2015), increasingly detailed climate modelling work has begun to sketch possible distributional climatic consequences of such imagined SRM interventions, treating them as concrete objects. As in the case of CDR, here the models also co-constitute as yet imaginary technologies, with very limited scope for empirical validation, and do so in a charged policy space in which the politics of climate denial largely prevents constructive questioning of modelling and its assumptions. This means that climate modellers arguably bear an elevated responsibility to consider the possible social consequences of their work. This paper seeks to suggest ways in which modellers, other climate researchers and policy makers could act reflexively to enhance contributions to justice in climate policy.

To investigate the justice implications of climate geoengineering means considering how it might affect people across plural dimensions of distribution, vulnerability, capability, structural inequalities, procedure, recognition, and restoration or correction ((Jasanoff, 2003; Mamo and Fishman 2013; Schlosberg 2007, 2012; Shrader-Frechette, 2002; Sen, 2009; Hourdequin 2016). Climate change is not simply a justice issue because its effects are spatially and temporally uneven, as often presumed in the climate geoengineering modelling literature, it is also a justice issue because vulnerability to those effects is also uneven, and tightly inter-linked with existing economic, political and cultural injustices and power imbalances, in which the victims are often poorly recognised, and compensation resisted (Athanasiou and Baer, 2002; Schlosberg, 2012). It cannot be assumed simply that a reduction in overall climate risks will necessarily enhance justice. It is important to ask who will lose or gain, where, when, and in what respects, including from the consequences of climate geoengineering for energy systems.

As outlined below, modelling of SAI predominantly suggests that it could - at a gross, global scale - significantly reduce, or at least mask, the impacts of unabated climate change. As it may now be too late to prevent dangerous climate change with mitigation alone, and insofar as the existing and likely impacts are disproportionately borne by the poor and disadvantaged, it might be argued that the deployment of SAI would enhance justice (Horton and Keith, 2016). But there are also reasons to significantly qualify or even dismiss such a claim. First SAI is not a perfect substitute for mitigation (Keith, 2013), and the distribution of residual and novel impacts could be important for an unknown proportion of the poor and disadvantaged. Second, insofar as SAI acts as a substitute for, or deters, mitigation (McLaren, 2016a; Morrow, 2014b), any negative side-effects of SAI would be magnified, and any co-benefits of mitigation reduced. Moreover any failure of SAI in practice would then result in more severe climate impacts than had mitigation not been deterred (Baatz, 2016). Third, justice has richer and plural dimensions - beyond those defined in terms of consequential harms and benefits (Sen, 2009) - in which climate risk may be a poor proxy for justice. In this paper I explore how the presumptions and practices of climate geoengineering modelling act to downplay such qualifications.

Before discussing the detailed findings and implications of climate geoengineering modelling, it is necessary to briefly consider the status and purpose of such scientific models. Researchers have developed increasingly sophisticated computer models – using both physical principles and historical climate data - in efforts to predict and understand the implications of rising greenhouse gas concentrations (Edwards 2011; Flato, 2011). Climate models have contributed to a substantial improvement in our understanding of the relationships between energy systems and climate change. They provide illuminating opportunities to simulate - and experiment with - alternative conditions, scenarios and pathways in ways that are simply impossible empirically. But this implies a responsibility to communicate assumptions and limitations carefully and clearly. Despite their benefits, in the context of bitterly contested climate politics, such caveats are rarely heard, even when offered. As a result climate models have been described as 'technologies of hubris,' offering a misplaced modernist concept of management and control that pre-empts political discussion (Jasanoff, 2003). They are embedded in an administrative risk-management social imaginary (Groves, 2014). They arguably constitute 'seductive simulations' (Lahsen, 2005), acting as gatekeepers of claims about climate change (Sundberg, 2007) and as boundary-ordering devices between science and authority that sideline uncertainty (Shackley and Wynne, 1996). As a result modelling co-constitutes particular sorts of worlds. It must be stressed at this point that such effects are not the intentional product of modellers, but an emergent result of the co-production of models, technologies, discourses, imaginaries and institutions in this space. Nonetheless, such models are now being deployed and further refined technically to explore the potential implications of climate geoengineering.

Because the future state of the climate and the effectiveness of climate policy are complex and indeterminate, the status that models are granted critically structures the interpretation of scientific evidence. Models may be treated in diverse ways across a spectrum from 'truth machines', to more honest 'sandpits' for experimentation (Galarraga and Szerszynski, 2012) or 'props in games of make-believe' (Toon, 2010). Audiences for models must 'play the game', which makes modelling a social activity (Corry, 2015). So the use and interpretation of models depends heavily on a shared language, vocabulary and grammar and is thus co-constituted with disciplinary discourses. Wiertz (2016), specifically examining climate geoengineering research, documents how the use of climate models as a primary site of knowledge production in climate geoengineering research requires *"'virtual technologies' as placeholders for speculative SRM methods*" (p.440). Climate models, he suggests, thereby become *"inventive tools used to refine and envision concepts of climate control …*" (p.453) whilst underlying presumptions, such as the models' reliance on a "*figure of a single rational decision maker who designs and evaluates the performance of the technology*" (p.454) remain unquestioned. Wiertz shows how model-based research shapes social and political expectations around technologies, and challenges us to question the "*relation between model-based and social visions of climate futures*" and the ethical and political questions raised by the practice of climate geoengineering modelling.

This paper takes up a key element of that challenge, exploring and unpacking both explicit and hidden assumptions about justice. These arise at several levels: first in the modellers' interpretation of their models' outputs; second in the modelling practices; and third in values or conceptions of justice which researchers (typically

unquestioningly) import into their modelling and analysis. The first part of the paper addresses each of these levels in turn, based on a focused review of the modelling literature. The second part of the paper then discusses how these interpretations, practices and values relate to discourses and framings of climate geoengineering with respect to risk, vulnerability and power, and considers the relevance of plural and relational dimensions of justice drawn from the environmental justice and science and technology studies literatures. Finally it draws conclusions regarding the implications of climate geoengineering for climate justice.

Representations of justice in modelling of SRM

Based on a broad literature review I identified all the studies prior to 2016 that address spatial distributional implications (at a regional scale, rather than just global impacts). These papers are considered in this section, alongside a number of more basic studies whose outputs are critical to understanding ways in which climate geoengineering might impact on justice. I first outline the key findings of these modelling studies regarding the potential distributional effects of SAI, and examine how they have been interpreted, particularly regarding consideration of winners and losers. I then turn to issues arising in the practices of modelling, with a focus on counterfactuals, uncertainties and vulnerability. Throughout, I quote directly from the modelling studies identified through the literature review to help illustrate relevant presumptions and practices. I conclude the section with a brief summary of the concepts of justice revealed by the modelling.

Model outputs and their interpretation

Much of what scientists understand of the likely implications of SAI comes from modelling studies. Early models of SAI simply simulated a reduction in incoming solar radiation, while more recent ones directly model stratospheric distributions of aerosols and are able to explore dynamic and distributed effects in more detail. The last decade has seen a rapid increase in climate geoengineering modelling, with increasingly sophisticated models, multiple model runs utilising increasing computer power, and in recent years, efforts to compare multiple models as part of the geoengineering model intercomparison project (GeoMIP) (Kravitz el al, 2014). There is broad consensus in the modelling community (dominated by US, UK and German scientists), over the large-scale effects of SAI, but still significant disagreement or uncertainty over many parameters of significance for regional impacts, such as cloud effects or ocean circulation.

Modelling suggests that even uniformly distributed reductions in solar radiation would have distributional consequences. Such SAI could not simultaneously compensate everywhere for changes in both precipitation and temperature. Changes in precipitation may be *"quite small relative to interannual variability at the regional scale*" (Bala et al, 2008:7668) but still significant. For instance, *"simulated temperature and precipitation in large regions such as China and India vary significantly with different trajectories for*

[SRM], and they diverge from historical baselines in different directions" (Ricke et al, 2010:537). The temperature offsets achievable through uniform global SAI are expected to be latitudinally distributed, with "*significant cooling of the tropics [but substantial residual] warming of high latitudes and related sea ice reduction*" (Lunt et al 2008:1). Aerosols also have dynamic effects on atmospheric, and consequentially oceanic circulation. In the southern hemisphere, SAI might even warm deep ocean currents around Antarctica, a key driver of ice-sheet collapse and sea-level rise (McCusker et al, 2015).

Modelling a larger aerosol loading in polar latitudes appears to compensate for the latitudinal distribution of temperature effects but not the ocean dynamics. Moreover it also "*tends to degrade the degree to which the hydrological cycle is restored*" (Ban-Weiss and Caldeira, 2010:1). And even fully masking average temperature change is predicted to only reduce, but not eliminate changes in weather extremes (Curry et al, 2014). Nor would it halt sea-level rise: to do that, as Irvine et al (2012) show, would require an average aerosol loading that would more than compensate for temperature rise.(1)

Distributional consequences from precipitation changes are not insignificant. Early modelling by Robock et al (2008) suggested that both tropical and Arctic SAI would result in "*a weakening of the African and Asian summer monsoon circulation, an effect found previously from high-latitude volcanic eruptions*" (p.8). However, more recent research has largely failed to reproduce such extreme effects. Nonetheless, MacMartin et al (2012) advocate seasonal distribution of SAI interventions to ameliorate the risk of negative effects on precipitation in monsoon regions, while Keith (2013) suggests that reduced evaporation at lower temperatures might offset the impacts on agriculture of any net reduction in precipitation. Yet over the past decades the effects of (tropospheric) aerosols from combustion processes have already weakened Asian monsoons, reducing precipitation (Polson et al, 2014). If SAI were heavily biased to one hemisphere the implications could be more dramatic. Haywood et al (2013:660) find that: "*large asymmetric stratospheric aerosol loadings concentrated in the Northern Hemisphere are a harbinger of Sahelian drought whereas those concentrated in the Southern Hemisphere induce a greening of the Sahel.*" A hemispherically asymmetric SRM intervention might be deliberate - not just a modelling fiction. Several authors have suggested Arctic dominated SRM (eg Lunt et al, 2008; MacMartin et al, 2012). Moreover, the only advocates for immediate deployment of SAI argue for Arctic deployment to prevent loss of sea ice and subsequent methane feedbacks.(2)

Some climate geoengineering modellers have responded to concerns over precipitation effects by modifying the scenarios they model. Yet the findings of such modelling are often interpreted and reported in ways that may underplay the implications of remaining distributional problems. Several studies have modelled levels of SAI that only partially mask temperature changes, to reduce the extent of harmful overcompensating precipitation changes. For example, Moreno-Cruz et al (2012) model returning an unabated 2xCO_2 2030 climate to 1990s temperatures, and report that separately each factor can be almost perfectly corrected (97-99%). However, their abstract's optimistic interpretation that "*while inequalities in the effectiveness of SRM are important, they may not be as severe as it is often assumed*" (p.649) is rather contradicted in the body of the paper. This notes that: "*Compensation is harder when one tries to optimize for both*

temperature and precipitation at once. … the SRM scheme that minimizes … precipitation changes compensates for only 70% of … temperature changes" (p.651).

And this remaining trade-off could have profound distributional consequences. Moreno-Cruz *et al* also state that: "*the first region to reach its optimum as we incrementally increase SRM is Western Africa … [where] the optimal amount of SRM … is 78% of the [full amount] ... An increase in the level of SRM beyond this point makes Western Africa worse-off*" (p.661). Moreno-Cruz et al estimate that 78% of full SRM would compensate for 56% of global damages from climate warming. But they choose not to draw out the disturbing implication that to optimise for any other region - the mainland USA for example – or to seek to mask a higher proportion of global damages, would therefore make things relatively worse for some of the poorest countries in the world, when comparing it with SRM optimized for Western Africa.

Others have attempted to quantify regional disparities arising from SAI by developing a concept of 'novel climate', with the apparent ambition of modulating their modelled interventions so as to minimise the incidence of such novel climates. However this has highly problematic consequences for the framing of the climate justice problem. Irvine et al (2010) define a novel climate as "*a climatic state, measured by either surface temperature or rainfall (annual or seasonal), that lies outside the continuum of climatic states bounded by the preindustrial and an unmitigated (4xCO_2) greenhouse" (p.5).* Their results show 'novel conditions' – primarily in precipitation, over up to 28-45% of the earth (from SAI designed to reverse 70-80% of the warming arising from 4xCO_2 (Irvine et al, 2010: figure 3b)). To interpret this, as the authors do, as limiting novel climate states to 'only a small fraction' of the earth (p6), seems overly optimistic. Furthermore, in Irvine et al's results, higher levels of SAI generate an even wider spread of both novel precipitation and temperature regimes. Yet their definition of novelty already normalises extreme climate change. A 4xCO_2 climate is massively beyond human experience. If it is 'novelty' that signals the potential for significant harmful regional changes, but a 4xCO_2 greenhouse is not considered novel, this frames the associated climate impacts of business as usual as more acceptable, so the historic injustices embedded in their causation are more easily overlooked.

Even if SAI could be restrained to reduce disruptive effects on precipitation, it appears that there would still be significant areas with novel and potentially harmful climatic conditions, and many different or new winners and losers. Model inter-comparison appears to confirm this. Kravitz et al (2014) model SAI restricted to compensate only 85% of the difference from preindustrial temperatures, and suggest that, in a world divided into 22 regions, this delivers regional temperatures closer to preindustrial levels than to a 4xCO_2 world *"for all regions and all models*" (p.1). However: *"in all but one model, there is at least one region for which no amount of solar reduction can restore precipitation toward its preindustrial value*" (p.1). Moreover, if only precipitation were considered significant, "*11 of the 12 models show the [optimum] amount of geoengineering determined by the Pareto criterion to be zero*"(p.4) and for nine of the 22 regions at least one model shows precipitation changes that exacerbate, rather than ameliorate, the effects of climate change. Yet again, the interpretation of this work is given an optimistic spin. By weighting temperature and precipitation effects equally in their overall evaluation these authors conclude that SAI would create 'no new winners

and losers'. In reality, though, such an equal weighting is misleading: some regions and groups would be far more vulnerable to temperature impacts than precipitation changes, and vice versa.

Some advocates of SRM research imply that such optimism is justified by the potential for targeting and modulating SAI. Kravitz et al, indeed, model only uniform global SRM. MacMartin et al (2012) introduce the possibility of fine-tuning both the latitudinal and seasonal distribution of SAI. They report that with such modulation: "*residual temperature and precipitation changes in the worst-off region can be reduced by 30% relative to uniform solar reduction"* (p.365). But such benefits may be as imaginary as the technologies involved: they depend strongly on assumptions of controllability and uniform vulnerability, as discussed in the next section.

Overall, therefore, the modelling appears to show that, in terms of *global average* effects, masking greenhouse forcings with SAI would probably leave most places better off than under unabated climate change. Yet SAI is not a perfect substitute for mitigation, nor can it restore previous climates.[3] SAI would reconfigure, or even make new climates, with serious implications for climate justice that must be considered in climate policy. There would be dynamic regional and temporal patterns of impact – at scales at which the model uncertainties are much greater - that could expose particular populations to continued or enhanced risk. A significant minority might suffer undesirable shifts in temperature or precipitation regimes, only some of which might be mitigated somewhat by more targeted and refined application of SAI, even if that were to prove practical. While early modelling studies arguably exaggerated the possible implications of such impacts, more recent work appears to downplay them. The next section turns to some of the modelling practices that would appear to structure such optimistic findings and interpretations.

The implications of model design and assumptions

Here I explore three key features of the modelling practices that help construct the optimistic narratives: use of inappropriate counterfactuals; overconfidence in the predictability and controllability of SAI; and largely ignoring variation in vulnerability. Not only do these features tend to over-simplify assessments and focus attention on specific dimensions of justice, while framing out others, but their effects also appear to structure and even pre-condition the findings that suggest that SRM could be just. This is not to suggest that models should be expanded to try to better incorporate justice, rather that presumptions about justice must be unpacked to create opportunities to explore and experiment with the implications of alternative assumptions and conceptions of justice.

Extreme counterfactuals, catastrophism and the clean sheet

Modelling studies typically contrast high greenhouse gas worlds (often a $4xCO_2$ greenhouse) in the presence or absence of SRM, rather than contrasting the outcomes of SRM with either preindustrial climates or the outcomes of partial mitigation. This

almost universal choice of counterfactual is often accompanied by claims that adequate mitigation has become politically or practically implausible (e.g. Keith, 2013). Mitigation effort may indeed be currently inadequate to avoid dangerous climate change, and it might even be true that no practical rate of improvement in mitigation could avert dangerous climate change; but it is unreasonable to presume that no progress will be made to reverse emissions growth even as impacts become severe and immediate.

Using a counterfactual of unabated climate change makes modeling results easier to identify and the effects of different factors easier to isolate, but it also exacerbates the potential for consideration of climate geoengineering to distract attention from other responses - the so called 'moral hazard' (Gardiner 2010; Morrow 2014b, Corner and Pidgeon 2014, McLaren 2016a). In its political form, moral hazard suggests decision makers may be tempted to avoid controversial or costly decisions to mitigate in favour of hypothetical future SRM. This would exacerbate risks for future generations if SAI failed to work as expected, or were prevented or halted by political disagreement. Inappropriate counterfactuals unintentionally foster a misleading impression that SRM is a direct alternative to mitigation (despite apparently well-intentioned assertions to the contrary by most researchers). Such counterfactuals also make SAI more palatable, because in comparisons with unabated climate change, any potential negative disparities arising from SAI appear less significant if the alternative appears to be a climate catastrophe. As shown above, such comparison has already restricted the identification of 'novel' or 'harmful' climates in some modelling work.

Moreover, this framing of the distributional consequences of unabated climate change presents them as virtually *inevitable*, if unintended, and thus in certain respects as of less moral consequence than if they were recognised as the result of active human agency (Morrow 2014a). This is not to claim that SRM modellers are unconcerned by climate injustice, rather that the construction of their models incidentally deflects attention from the historic causes of that injustice and the potential for its attempted rectification by accelerated mitigation. The more the framing of the models reinforces political and research claims that it is physically impractical and politically unrealistic to avoid a high greenhouse gas world due to the combination of climate and economic inertia (McLaren 2016b), and the more focus is drawn to technological means of avoiding the extremes of climate impacts, the less attention will be paid to any moral obligations arising from historic emissions. In this way the models reflect a sort of 'clean sheet' analysis that looks only forward, and in which past responsibility for emissions, and any form of corrective justice, is not taken into account.

Uncertainty and control

As seen in the quotes so far, the language of modelling is replete with claims that SAI 'can', or 'will' deliver certain outcomes, or could be managed, modulated, targeted, or optimised. However, not only are these claims products only of modelling, not empirical experiments, they also ignore the practicalities of delivery and control. Bellamy (2016), following Stirling (2003), criticises climate geoengineering appraisals generally for a narrow focus on risk and a failure to recognise uncertainties. The modelling literature largely assumes away uncertainties in three spheres: in the technologies for SAI, within

the models themselves, and in the monitoring and control mechanisms that would connect them. Such uncertainties may be critical to judgements about the desirability of SAI. In particular, if SAI might not be practically realisable or controllable, then any deterrent or delay to mitigation becomes much more risky.

In the first sphere, even the most optimistic researchers concede significant 'non-trivial' uncertainties that demand further research into SAI technologies (Keith, 2013) while other natural and social scientists suggest the technical challenges may be so great that a practical, cost-effective and socially and politically acceptable system may never be feasible (Hunt cited in Koplewitz, 2015; Stilgoe 2015). In other words, technologies for precise and controllable delivery of aerosols imagined in the modelling might remain imaginary, called into being only by the parameters and functioning of the models (Wiertz, 2016). This offers little confidence that SAI could be targeted effectively. Yet MacMartin et al (2012) largely dismiss the question. They confess: *"We do not address how one might achieve the desired forcing distributions*" (p.367), but argue that "*Although these variations may be difficult to achieve in practice, it is premature to presume today what variations might ultimately be achievable … [future] engineered particles or space-based systems might enable more control over the distribution of solar reduction*" (p.366).

Even if the physical challenges can be surmounted, managed delivery would rely on models that permit us reasonably to predict the climate outcomes of any climate geoengineering intervention, and control systems that would deliver the desired effects, in the face of huge lags and complexity in feedbacks (also attributed using models). The uncertainties involved in this second sphere are also substantial. To confidently predict the sort of detail reported above would require models that accurately reflect complex connections between different climatic regions, yet even the interactions between hemispheres and latitudes are only now emerging (Haywood et al, 2013). For example, climate models generally fail to capture several significant dynamic responses in the northern hemisphere observed following tropical volcanic eruptions (Driscoll et al, 2012) and often miss dynamic effects of aerosols on ocean circulation in the southern hemisphere (McCusker et al, 2015). This may not cast doubt on the potential for SAI to cool the climate generally, but must give researchers pause in claiming that they can predict regional effects adequately.

When considering the uncertainty in models, the distinctions between runs, ensembles, and controlled inter-model comparisons must be acknowledged. Individual runs have inherent variability. Ensembles can embody consistent biases. Inter-comparison studies encompass a broader range of possible outcomes, but are still constrained by the selection of scenarios, and can establish dominant framings and path dependencies (Sundberg, 2011). Although climate models can clearly be improved further, they will inevitably remain inherently incomplete and uncertain (Stilgoe, 2015). Moreover, seeking to reduce variations in modelled climatic responses may distract attention disproportionately from the implications of social, economic, cultural and political vulnerabilities, considered in the next section.

In the third sphere, technical controllability, the literature is sparse. MacMartin et al (2013, 2014) find that cybernetic feedback can be used to control model temperature outputs, even with limited understanding and a crude model. However they note fundamental trade-offs, such that managing uncertainty risks amplifying variability.

Their approach is essentially technocratic, although they do acknowledge that technical requirements for rapid feedback control *"may be incompatible with … a stable decision-making process that is able to gain legitimacy*" (2013:255). Jackson et al (2015) report an experimental approach that begins to explore such problems, using two layers of modelling and iteration of interventions in annual rounds, targeting Arctic sea-ice retention. The researchers were able to establish control over the model (after about a decade), but their experience suggests that in reality, with political and social influences as well as technical ones, the controllability of SRM remains highly uncertain. And even if control were to prove plausible, it would raise serious procedural justice questions regarding how all those affected might participate in governance of a managed climate.

At the present state of knowledge, moreover, SAI would appear to involve a wider range and scale of uncertainties than mitigation. These uncertainties mean that climate impacts may be more evenly or unevenly distributed than the models imply: but equally critically, the level of uncertainty itself is significant for justice in the same way as climate variability. Groups with greater capabilities, strong social capital, and majority recognition are simply less vulnerable to uncertainty about future climates than those with weak capabilities, limited social capital or suffering misrecognition.

Variation in vulnerability

Other features of the modelling methodologies and practices – especially the implicit characterisation of affected populations – also shape how justice implications are revealed and interpreted. Inappropriate criteria, aggregation and implicit assumptions of uniform preferences and values can all act to frame out important dimensions and questions of vulnerability. Vulnerability shapes experiences of extreme weather more than meteorology (Stilgoe, 2015); and for climate impacts, vulnerability matters as much or more than the physical climate outcomes. In *climate impacts* assessment, vulnerability and exposure are considered separately to physical outcomes, but for *climate geoengineering* such a systematic approach is currently lacking.

Varied vulnerability to factors such as heatwaves, drought, or the timing of rainfall or frosts could exacerbate distributional inequalities. The simplistic indicators used in modelling, such as economic value, crop production or demographic weighting, do not reflect the reality that *"in different regions different kinds of changes matter* … [and] *relevant physical indicators for an assessment of SRM impacts are likely to vary between and even within regions*" (Heyen et al, 2015: 12). Most modelling also presupposes that all affected populations have the same underlying preferences. But: "*even limited variation in actors' preferences about a target climate state can significantly change assessments of regional disparities from SRM*" (Heyen et al, 2015: 2). Once additional climate variables - beyond average temperature and precipitation - are considered, the likelihood of such disagreements grows. As a result, those who control the choice of model, the choice of criteria and the weightings given to different factors hold a great deal of discursive power.

Moreno-Cruz et al (2012) contrast SRM deployment under outcomes weighted by 'utilitarian' economic output, and 'egalitarian' population numbers. They estimate that: "*precipitation induced population-weighted damages will increase by 51% if we optimize*

for output-weighted temperature damages ... [but] *minimizing population-weighted precipitation changes simultaneously compensates for [only] 69% of utilitarian temperature damages*" (p659). In other words, while there are significant overlaps, political contestation could well result from different underlying values. Aaheim et al (2015) model economic consequences, and also find a mix of winners and losers from SRM, with some regions where the economic effects are negative in all their scenarios.

Increasing computational capacity and improved data has tempted modellers to try to assess distributional implications in such ways, potentially generating useful inputs for political discussion. Nonetheless technical limitations of climate models and data availability mean researchers have "*tended to assess regional disparities on spatial levels ... that do not match with any socially meaningful categories*" (Heyen et al, 2015:13). Irvine et al (2010) make their conclusions based on just five 'illustrative' regions (US mainland, Western Europe, Eastern China, Australia and Brazil). Such aggregation "*averages out small scale spatial differences ...* [producing] *more positive assessments of SRM's distributional effects*" (Heyen et al, 2015:13). Modellers also aggregate temporally over multi-year periods, thus potentially underweighting changes in annual variability and extreme events.

Aggregation is just one of the ways in which uncertainty – which multiplies at smaller scales - is de-emphasized. Moreover, vulnerability is not just a function of location, for example, being dramatically different for waged and subsistence populations in the same localities. Vulnerability is variegated in multiple dimensions. And some vulnerabilities would not be reduced significantly by SAI. SRM does not reduce ocean acidification, or its impacts on communities dependent on fisheries or the protective effects of growing reefs. Insofar as climate geoengineering exerts any deterrent on mitigation, such impacts would then be exacerbated. Such deterrent effects would also sustain existing injustices in the fossil energy system, particularly those associated with extraction of fossil fuels or the distributed effects of air pollution from combustion in power generation or vehicles.

Revealed conceptions of justice

Collectively – and perhaps in response to climate policy-makers' demands for greater certainty - this literature tends to treat models primarily as truth machines that can be refined and tweaked to provide an ever-improving representation or prediction of reality. Although modellers often question their approaches and assumptions, and take care to specify *technical* uncertainties, the mode of such questioning rarely engages with more fundamental questions regarding the purpose or nature of modelling, nor the values and conceptions of justice embedded in the practices of modelling. This might represent defensiveness about the validity of climate modelling resulting from political controversy and the attacks of climate denialists; but as shown in the preceding section, it can have serious implications. Here I briefly summarize the largely unquestioned conceptions of justice revealed in the modelling literature.

In modelling efforts to minimise trade-offs and 'optimise' SAI, the approach to ethics and justice is primarily consequentialist (embedded in a liberal social imaginary of risk-

management (Groves 2014)). Harms and benefits experienced by people are central, rather than deontological rules of action. The literature tends to overlook the prospect that not all those disadvantaged by climate change could be compensated by SAI, and indeed some may even experience a worse situation; or engages with it only in ways that treat these losers as acceptable collateral in a utilitarian balance. The underlying assumptions – rarely offered explicitly – are broadly utilitarian: justice is found in minimising aggregate suffering, or maximising aggregate wellbeing (Sinnott-Armstrong, 2015).

These underlying philosophies are sometimes accompanied by distributional conceptions of justice, which particularly reflect Rawlsian western liberal approaches (Rawls, 1971; Lamont and Favor, 2013). A few modellers (eg Moreno-Cruz et al, 2012) pay attention to the regional distribution of climate outcomes, and explore ways to minimise harms to the most disadvantaged groups. While the Pareto-optimisation approaches typically applied are rather utilitarian, the idea that disparities are acceptable only where they benefit the worst off (Rawls' 'difference principle') also seems influential. However, as the preceding sections show, claims about the distributional justice of SAI arising from the modelling literature are rather less certain than might first appear. The potential for countervailing mitigation-deterrent effects, for greater uncertainties and for differently variegated vulnerabilities all make it difficult to draw meaningful conclusions in a liberal justice paradigm.

Collectively these factors also suggest that SAI might be less just than it might appear on the face of the models, especially if considered against a broader set of dimensions of justice. The next section begins to develop such a broader, plural approach.

Conceptions of justice and discourses of climate geoengineering

A single transcendental theory of justice is inadequate in addressing climate change and its causes. Not only will political responses to climate change and climate geoengineering depend on varied impacts and preferences for particular climate outcomes, they will equally depend on how various cultures interpret and conceive of justice. Here I therefore identify ways in which broader conceptions of justice, beyond distribution, might be relevant – considering each of the plural dimensions identified by environmental justice scholars (Schlosberg, 2007) in turn, and discussing how they are framed out in the modelling literature. I then connect these framing effects with predominant discourses in climate geoengineering science and politics. This is a disembodied analysis, in which the principles embodied in climate geoengineering modelling are derived from the literature. It does not seek to impute motivations or beliefs to the modellers, but rather to surface the constraints and limitations of their work, within the co-produced cultural, economic and institutional context of climate science and policy, with the hope of stimulating more reflexive responses.

Broadening conceptions of justice

Procedural justice focuses on the involvement of people in decisions that affect them. Just as public engagement in the development and design of new technology is critical because technologies can reshape moral landscapes and help lock-in particular social practices (Cotton 2014; Stilgoe, 2015), so is public engagement in the design of models. But with rare exceptions, models and scenarios are typically constructed with no consultation of publics, which could helpfully be used to inform the choices of technologies, parameters or scenarios to model or even to shape the criteria informing the research as a whole (Bellamy et al 2014).[4] This shortcoming privileges expertise, fails to recognise the necessarily partial nature of scientific knowledge (Ottinger, 2013) and treats justice as something determined by elite institutions, rather than something participatory and procedural (McLaren et al 2013). Such procedural aspects are especially important insofar as climate geoengineering converts future climates into chosen, intentional artifacts, rather than unintended side effects of other beneficial activities. Intentionality reconfigures moral considerations (Morrow 2014a). It also makes it as important to scrutinise the implications of not using the technologies as the implications of deployment, and introduces new dynamics and challenges to international politics.

Effective procedural justice and participatory parity demand recognition of people's status as full moral equals in society (Fraser and Honneth, 2003). In largely ignoring vulnerabilities, and aggregating across multiple individuals, the models however presuppose an artificial equality, as real world capacities to participate are also highly variegated, and often constrained by institutional and cultural misrecognition. Similarly in applying implicit value assumptions about universal and equal preferences and criteria, the models fail to recognise real cultural variation. Justice as recognition demands taking account of existing difference, not just of our common humanity.

Lack of attention to variation in vulnerability also exposes the ways in which conceptions of justice drawing on capabilities (Sen, 2009) or care (Held, 2006) are overlooked in considering the implications of the models. The capabilities approach focuses on justice as freedom – enabled by universal enjoyment of essential capabilities for functioning such as political participation, health and education. Yet actually existing capabilities are unequal. Justice in capability terms demands investment in capabilities, building power, enabling people and communities to function without dependency and domination. Like the ethics of care, it implies a focusing of our capacity to care on those who are vulnerable, ideally supporting them to obtain functioning and autonomy.

Rather than supporting building capabilities and thus social resilience, the climate modelling approaches and practices instead effectively prioritise the 'removal of a hazard' (the physical climate outcome). This represents a hierarchical model of control that is at worst a form of domination and at best, elitist paternalism. It treats those affected by climate change as powerless victims, not as potentially capable actors able to participate in determining the conditions of their lives – including participating in climate politics. This territory is implicitly reserved for the scientific and political elites – notably in the countries which dominate climate geoengineering research: the US, UK, Germany and to a lesser degree, China. Moreover, if SRM merely masks the threat of climate injustice to future generations, rather than structurally or institutionally

removing it in the way mitigation and adaptation do (Smith 2012), then there is an equivalent intergenerational injustice involved. Put another way, mitigation and adaptation would appear inherently more supportive of future people's freedoms and capabilities because they reduce vulnerability to domination. But this distinction is not acknowledged in the ways the models construct affected populations.

Finally, in ignoring existing inequalities, vulnerabilities and misrecognition, the modelling literature reinforces a 'clean sheet' framing that excludes corrective or reparative justice. Reconciliation, reparation and even punishment can be central to justice, especially where vulnerability is a product of previous injustice. So restrictions and financial burdens imposed on carbon-intensive corporations and nations by accelerated mitigation and adaptation financing can be understood as a concrete representation of climate justice. Corrective or restorative justice also ensures that a focus on the victims of climate change does not cause us to ignore the perpetrators: which seems critical as addressing the problem demands changes in their behaviours. Space precludes a deeper exploration of restorative justice here, but it seems clear that whether the aim is 'punishment' of climate criminals, or reconciliation between the perpetrators and victims of climate change, climate geoengineering rather acts to dismiss both the need for, and possible mechanisms of, such corrective justice. Moreover any moral hazard effect also reduces the corrective implications of mitigation and adaptation, leaving those who have profited from the causes of climate change to continue to enjoy their benefits.

Framing out justice, ignoring power

The foregoing suggests that the modelling literature embodies narrow, largely utilitarian, conceptions of justice. Moreover, in the ways it constructs and reconstructs climate change narratives this helps frame out richer conceptions of justice and understandings of power -understood here as asymmetric capability or agency (Stirling, 2014).

The technological optimism of the modelling literature frames SAI as practical, manageable and governable. The counterfactual of unabated climate change reproduces a 'political realism' in which mitigation remains minimal. Together these risk a form of post-political, technological solutionism (McLaren 2016b), which presents another source of moral hazard. In the face of the constraints and difficulties of international climate politics, it should not be surprising that researchers and modellers are keen to explore climate geoengineering, even while they continue to advocate accelerated mitigation and adaptation. However, the solutionist mind-set redefines problems such that the novel technology appears as the solution, notably in ways that bypass messy political, cultural or behavioural changes (Morozov, 2013). Reducing consumption, changing profligate lifestyles, or adopting costly or inconvenient practices becomes not only impractical but also unnecessary in solutionist responses to climate change. Yet these are the responses typically advocated as essential to deliver climate justice (Athanasiou and Baer, 2002).

Solutionism shifts power and authority from politics to science and technology, but typically without democratising the latter. Simultaneously, the high apparent leverage of

SAI forms of SRM could be expected to concentrate power, giving it an essentially centralising and autocratic 'social constitution' (Szersynski et al, 2013). In this light, a scheme of SRM designed to benefit the poorest (such as those explored by Moreno-Cruz et al 2012) would seem unlikely to be implemented even if technically feasible (Stilgoe 2015). The new climates resulting from SAI suggest incentives for powerful nations to prefer distributional patterns that could impose greater risks on poorer and less powerful groups. Such an outcome need not rely on unilateral imposition, as poorer countries might well accede to a distributional schema designed by the powerful for its generic benefits or for other political reasons. Nor can we assume that the political interests of poor country governments would coincide with the interests of their poorest inhabitants.

Power is perhaps overlooked for the same reasons as moral hazard: SRM modellers typically treat technology as something morally neutral, on which they can act, but which does not act on them. But technologies not only cause us to adjust our behaviours but also reframe our moral and political choices (Verbeek, 2011; Cotton, 2014). Even the technical capacity to model climate geoengineering has such a reframing effect, in that simulations based on SRM open questions of desirable climate outcomes or 'designer climates' (Wiertz, 2016). Justice is only one dimension of the moral choices raised here, but other aspects lie beyond the scope of this paper.

If the technologies of climate modelling - like those of climate geoengineering – are understood as embedded co-constituted parts of socio-technical systems, it becomes easier to understand how modelling designs exert agency within a system; how moral questions extend to the design and assumptions of models, not only their use and interpretation; and that values and facts cannot be treated as independent, but are different aspects of a system in which politics, power and technology are co-constituted. Of course justice should be similarly conceptualised – as it is in environmental justice theory - as something negotiated, contested and co-constituted, not as something separate, abstract and ideal. By treating models as games of make-believe, researchers could not only open up climate geoengineering appraisal (Bellamy, 2016) but also create opportunities to experiment (both with, and on) the models, as Stilgoe suggests (2015), in ways that assist with deliberation and negotiation over both climate technologies and climate justice. There is great potential for scientific collaborations across disciplines to conduct different analyses with the models, and conduct modelling experiments using different concepts of justice to help challenge the shortcomings identified here. Social science is not only valuable for communicating the results of modelling to the public and policy makers, but integrated into research programs it can help introduce social values and concerns into the design of modelling experiments.

And of course, models are only part of the complex machinery used to anticipate the future. We cannot expect modelling and modellers to solve all these problems alone. But in the case of climate policy, modelling is central not only to other forms of anticipation and speculation (Stilgoe, 2015) but to the politics and epistemology of climate change. So it is critical to challenge how models are constructed and deployed, and to understand how political and social values – for example about risk, participation or justice - are embodied through design assumptions. Re-building models to respond to such an understanding will not be easy. Researchers should seek to recognize and

understand the limitations of models, and seek to compensate for them. That the models will nevertheless remain incomplete does not render them irrelevant or inappropriate. It does, however, mandate that the models be put into dialogue with ethical and moral discourse. Designing models and experiments on models that deploy a reflexive approach to SAI, as in some ways a subject rather than only an object, should be the goal. Modelling should experiment with a wider range of counterfactuals; with scenarios designed through public engagement; with more random variation to simulate control problems; and more experiments using real human beings as control actors, representing diverse interests. This means designing trans-disciplinary research programs that genuinely engage with political, social and cultural dimensions of climate policy, not merely seeking to abstractly model the political and social alongside the scientific.

Conclusions

In summary, the values and conceptions of justice revealed as underpinning SRM modelling exercises and the representations they produce are predominantly consequential rather than procedural; attending to the distribution of benefits and harms, rather than to underlying capabilities; individualist and aggregative rather than collective; fail to raise questions of recognition, vulnerability and reparation; and largely rooted in western, liberal conceptions of justice which ignore international cultural and political variations. The literature mainly displays a utilitarian bent, accepting and reinforcing substantial economic inequality, in the name of political realism - presuming that radical socio-economic change is infeasible, even while exploring ways to reduce other dimensions of climate injustice. This does not necessarily reflect the personal convictions of the researchers involved, but is a product of practical limitations of modelling, combined with the co-produced discourses, imaginaries and institutions that constrain and condition the agency of modellers.

Although SAI might offer justice gains when contrasted with unabated climate change, when compared with perfect mitigation it appears much less just. But neither unabated climate change nor perfect mitigation is plausible: it is essential to explore relative justice effects in responses involving mixtures of more or less mitigation, adaptation and climate geoengineering. In this context it is problematic that SAI techniques would not only generate different winners and losers with reconfigured climates but also distribute power, freedoms and capabilities in new and potentially harmful ways across populations and generations.

The climate geoengineering modelling literature also tends to overlook or devalue issues such as the relative vulnerability of affected populations; extant obligations resulting from disproportionate historical contributions to emissions; the distribution of power to decide over the design of any SAI intervention; the extent to which uncertainties in controllability and governance of SAI could undermine efforts to mitigate distributional impacts; the ethical implications of the intentional creation of new climates. All these would appear to contribute to the risks of a 'moral hazard' effect delaying or deterring mitigation (McLaren, 2016a), and thus increasing exposure to any

harms from climate geoengineering, residual climate change and sustained extraction and use of fossil fuels in energy systems.

In part these are products of a broader epistemic problem of hubristically treating and portraying climate models as truth-machines rather than games of make-believe or sandpits. This paper has suggested particular shortcomings in the climate geoengineering literature's often implicit assumptions of effectiveness, precision and controllability, its metrics and methods of aggregation, and its use of an excessive counterfactual of unabated climate change. The first means that risks of failure, moral hazard and uncertain distributional effects over space and time all receive inadequate attention. The second fails to recognise localised and variegated vulnerability and existing inequalities that might be exacerbated. And the last misrepresents the avoidance of a high greenhouse gas world as impractical and politically unrealistic, focusing attention on technological means of avoiding the extremes of climate impacts and away from moral obligations arising from historic emissions.

As a result, the dominant constructions of justice in climate geoengineering appear likely to bolster the existing power of global, Northern elites to resist demands for climate justice from predominantly Southern subaltern groups. In failing to engage with the heterogeneity of justice as procedure, reparation, freedom, recognition, or care for the vulnerable the discipline risks diminishing the prospects of responses to climate change that genuinely enhance global justice.

The promise of climate geoengineering – control over the climate – is also a threat, if future climates might be controlled or chosen by the powerful, in line with their interests and values. The modelling outcomes indicate that it would be unfair if 'interests' referred only to *climate preferences*. It would be even worse if the possibility of climate geoengineering were mobilised to restrict mitigation and protect elite *financial interests* in the current high-carbon fossil-fuelled economy. The question of who controls the *technology* is clearly critical. But even while the technologies themselves remain imaginaries, modelling also raises the question of who controls the *discourses* that effectively arbitrate what is and is not practical and just in climate policy. Focusing on the outcomes of models avoids accountability for the assumptions and conceptions of justice involved in building them. Rather than promoting deliberation and reflection, the scientific discourses risk prematurely closing down debate. Just like the moral implications of climate geoengineering, the moral implications of modelling must be taken seriously in design as well as use.

Endnotes

1. Neither, however, could accelerated mitigation be expected to halt sea-level rise.
2. See for example: http://a-m-e-g.blogspot.se/2012/05/message-from-arctic-methane-emergency.html.
3. Strictly, given complexity, no future climate would be the same as a past climate. Yet the modelling literature often refers to 'restoring' climate states.

4. The Integrated Assessment of Geoengineering Proposals project (http://www.iagp.ac.uk) was an exception in that deliberative public engagement influenced both the research programme, and the scenarios 87modeled.

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Paper 3: Public Conceptions of Justice in Climate Engineering: Evidence from secondary analysis of public deliberation

Paper 3 reports secondary analysis of transcripts of public dialogues on CGE. The analysis indicates that justice concerns are an important but as yet under-recognized dimension influencing public reactions to these emerging techniques. The paper describes and explores justice issues raised by participants in a series of deliberative public engagement meetings. Such justice issues included the distribution of costs and benefits across space and time; the relative power and influence of beneficiaries and others; and the weakness of procedural justice measures that might protect public interests in decision making about climate engineering. It argues that publics are mobilizing diverse concepts of justice, echoing both philosophical and pragmatic sources, and concludes that a better understanding of conceptions of justice in this context could assist exploration and understanding of public perceptions of and attitudes towards climate engineering and the different technologies involved. It suggests that such detailed public engagement would appear essential if sound, well-informed and morally justifiable decisions are to be made regarding research or development of climate engineering.

Paper 3 finds that, in contrast to CGE researchers, deliberative publics draw on a much broader set of justice concepts with regard to the uncertainties of climate change and geoengineering (including the prospects of mitigation deterrence). The focus on issues of interests and power highlight that for publics, questions of justice are political, not managerial.

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Public conceptions of justice in climate engineering: Evidence from secondary analysis of public deliberation

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ABSTRACT

Secondary analysis of transcripts of public dialogues on climate engineering indicates that justice concerns are an important but as yet under-recognised dimension influencing public reactions to these emerging techniques. This paper describes and explores justice issues raised by participants in a series of deliberative public engagement meetings. Such justice issues included the distribution of costs and benefits across space and time; the relative power and influence of beneficiaries and others; and the weakness of procedural justice measures that might protect public interests in decision making about climate engineering. We argue that publics are mobilising diverse concepts of justice, echoing both philosophical and practical sources. We conclude that a better understanding of conceptions of justice in this context could assist exploration and understanding of public perceptions of and attitudes towards climate engineering and the different technologies involved. Such detailed public engagement would appear essential if sound, well-informed and morally justifiable decisions are to be made regarding research or development of climate engineering.

1. Introduction

Questions of justice are central to climate change, and issues of ethics have been repeatedly raised in considerations of climate engineering as a policy response (Gardiner, 2010; Preston, 2012; Burns 2013). Yet questions of ethics and justice with respect to publics remain as yet relatively unexplored, despite increasing interest in climate engineering following the Paris climate accord in 2015 (e.g. Nicholson and Thompson, 2016; Williamson, 2016). This paper aims to establish whether justice implications are a significant factor in public reactions to climate engineering and to consider which conceptions of justice public expressions of concerns regarding climate engineering might reflect. It proceeds with a brief review of justice issues as arising in climate engineering and related literature to establish the context. After outlining the methodology applied, the paper then turns to examination of four justice issues prevalent in a series of deliberative public engagement meetings (moral hazard, environmental dumping, vested interests and fair procedures). Finally, we discuss the different ways justice is expressed and underlying conceptions are mobilized indicating important implications for policy and fertile lines of future investigation.

2. Climate engineering and justice in the literature

Climate engineering encompasses a diverse group of emerging technologies and techniques that seek to directly intervene in the planetary climate system to counter or reduce the negative effects of climate change (Royal Society, 2009; NAS, 2015a,b). It is commonly divided into methods that reduce the warming from incoming sunlight (solar radiation management or SRM) and methods that remove carbon dioxide from the atmosphere (carbon dioxide removal or CDR). The deployment of SRM is highly controversial, but CDR, on the other hand, is assumed in some form in most decarbonisation pathways which would limit global

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temperature rises to below 2 °C (UNEP, 2015). SRM and CDR share some ethical characteristics: for example both raise serious concerns regarding the prospect that their apparent future availability justifies continued delay to mitigation and adaptation. Although they can raise distinctive issues for policy (NAS, 2015a,b), this paper highlights public concerns that are largely common to both sets of technologies.

The unevenly distributed nature over space and time of both the impacts of climate change and the burdens of mitigation and adaptation has strongly shaped international negotiations – most recently at Paris – and domestic policies in many nations (Adger et al., 2006; Pickering et al., 2012; Schlosberg, 2012). At the same time, public responses to potential mitigation technologies such as nuclear power and carbon capture and storage have been shaped by environmental justice concerns such as the dumping of wastes on vulnerable communities (Bickerstaff et al., 2013; Shrader-Frechette, 2002; Walker, 2012; Taebi and Roeser, 2015). Given the prominence of justice concerns related to climate change mitigation and adaptation amongst academics and policy-makers, we believe it is important to scrutinise the justice implications of climate engineering as a response to climate change.

There are sound reasons to anticipate significant justice implications, both from the potential outcomes (intended and unintended) and from the power and scope of the technologies involved. Ethicists and philosophers (e.g. Gardiner, 2010) engaging with climate engineering have raised multiple issues including serious justice concerns as well as questions over whether the levels of interference with – or control over – nature implied by climate engineering are ethically acceptable and whether climate engineering may result in new injustices, and not simply act to mitigate the likely injustices of climate change. Gardiner (2010) suggests climate engineering would exacerbate the 'moral corruption' problem, adding to disincentives for the wealthy current generation to take effective action. Gardiner argues that in such situations those who have gained from business as usual will be tempted to support partial or inadequate responses that justify maintaining their present advantages. He suggests this is an acute problem in climate change because of the simultaneous separation of those responsible from those most affected in both time and space. This results in a form of 'moral hazard' in which apparent insurance against damage leads to riskier behaviour, which typically imposes costs or risks on others (Krugman, 2009). Preston (2012) suggests climate engineering might further compound the injustices of climate change by adding new uncertainties over rainfall patterns, for example, to which the poorest are most vulnerable. In addition, Burns (2013) emphasizes the intergenerational risks of rapid warming should a climate engineering programme be abruptly terminated, while Smith (2012) sees climate engineering as an unacceptable domination of future generations by present generations.

However, as a whole, as Oldham et al. (2014) show, the climate engineering literature is dominated by natural sciences with a focus on assessment of the potential and practicalities of climate engineering technologies, often using modelling techniques to explore climatic implications. Some modellers have examined the distribution of certain climate impacts likely to arise in the presence of climate engineering (Irvine et al., 2010; Ricke et al., 2010; Moreno-Cruz et al., 2012). But these modelling approaches are in a minority, limited in their approach, and typically, and implicitly, assume liberal utilitarian and distributional concepts of justice – in the forms discussed by Lamont and Favor (2013) – with simplistic portrayals of public interests and vulnerabilities in which publics are invisible, or at best imagined (Walker et al., 2010).

Justice considerations are also largely absent in the dominant climate engineering media discourses. Content analyses of climate engineering discourses (such as Nehrlich and Jaspal, 2012; Scholte et al., 2013; Anselm and Hansson, 2014) rarely mention justice. In her commentary on media analyses Buck (2012) reports that "*the justice issue is seldom considered; [and] even when it was present, it was rarely the dominant frame*" (p176). McLaren (forthcoming) suggests that the dominant discourses around climate engineering have acted to frame justice considerations out of the debate, through a combination of 'post-political' technological optimism and catastrophic portrayals of climate change.

In contrast, justice features more strongly in the findings of public engagement studies on climate mitigation technologies such as carbon capture and storage (CCS) (McLaren, 2012). While other ethical concerns such as 'messing with nature' have been reported in some detail (Corner et al., 2013), questions of justice appear occasionally in brief mentions of distributional concerns and most often obliquely in discussions of governance and authority. Parkhill et al. (2013) note that participants in their dialogues raised questions about governance, accountability and transparency, as do Bellamy et al. (2014) who note participants' demands for informed consent. Macnaghten and Szerszynski (2012) suggest their deliberative groups reveal a deep scepticism about climate engineering technologies and their potentially undemocratic nature. Wibeck et al. (2015) also note lay concerns raised in Swedish focus groups about governance, the locus of power, and the prospect of Southern nations being further disadvantaged. Such reports of public deliberation, then, only offer tantalising hints at wider justice concerns.

This paper aims to start to fill this lacuna – the lack of systematic exploration of the dimensions of justice related to climate engineering, as articulated or intimated by various publics – through a secondary analysis of a series of public deliberative events held in the UK. We seek to explore whether this gap represents a lack of concern or salience; or is a product of ways in which the topics were framed and discussed; or – as we believe – that the issues are influential, yet taken for granted and rarely directly expressed. In addition, we aim to begin to explore the nature and sources of the issues raised and the conceptions of justice mobilised in public deliberation.

Our identification and analysis of justice concerns is informed by a broad-based understanding of both scholarly and movement-based conceptions of justice (Schlosberg, 2007; Sen, 2009; Stumpf et al., 2015). The recognition of vulnerability, and resulting movement-based claims of justice rooted in lived experience are particularly significant in environmental justice approaches (Schlosberg, 2007; Walker, 2012). We consider justice concerns to extend to domains of distribution, procedure and correction, and include approaches based in human rights, capabilities, and recognition (Caney, 2010; Honneth and Fraser, 2003; Schlosberg, 2012). Justice concerns also arise in virtue ethics, where concern for others and for fairness is an indication of good character or a 'virtue of justice' (Slote, 2014). This broad understanding acknowledges the prospect of diverse motivations for justice and diverse sources of public interpretations of justice. Public interpretations might arise from abstract philosophical theories (ranging from egalitarian to libertarian in orientation), or from assessments of the characteristics of the technologies or procedures under consideration (Cotton, 2014), but in practice we might expect real world experience and analogues, and political and social movement claims to be more influential in shaping lay concepts. Different conceptions are important influences shaping the ways in which justice can be understood and promoted in practice. Cosmopolitan concepts that suggest equal treatment of all people regardless of their relatedness or proximity to us (Caney, 2010) might recommend different practical policies than communitarian approaches (Sandel, 2009), especially in international and intergenerational contexts.

The presence and salience of justice is not just an academic question, particularly given its presence in other public debates over emerging technologies, but also a substantive one given its importance in negotiations over climate policy. Variations in expressions and conceptions of justice are expected to have significance for formal and informal governance regimes for both research and possible deployment of climate engineering.

3. Public engagement and methodological issues

The research value of deliberative methods is well established particularly with respect to appraisal of novel technology (Macnaghten et al., 2005; Pidgeon and Rogers-Hayden, 2007; Delgado et al., 2010; Jasanoff, 2011), but also with respect to energy and climate issues (Capstick et al., 2015; Bellamy et al., 2014; Butler et al., 2013; Corner et al., 2013; Pidgeon et al., 2014). The ability of deliberative methods to 'open-up' assessment to a wider range of interests and considerations (Stirling, 2008; Bellamy et al., 2013) is critical. A deliberative approach is similarly apposite for justice considerations because they can arise in or represent a diverse range of ethical stances (from libertarian to egalitarian), which equally merit being 'opened up' for discussion. As Capstick et al. (2015, 3–4) argue, deliberative "research can generate depth of explanation and insight into why people have the attitudes they do, the discourses they construct and draw upon, and the complexity of their understanding and emotional engagement" with the issue under discussion. As participants project their lived experiences onto novel attitudinal objects such as imagined futures and technologies, they also reveal the values and principles they mobilize to consider the potential risks and consequences of those futures.

Deliberative research is therefore important in delivering the 'interpretive role' of science and technology studies (Jasanoff, 2011), and offers both substantive and instrumental benefits for the governance of science and technology (Fiorino, 1990). Our focus on justice considerations deliberately evokes the normative purposes of engagement and technology appraisal highlighted by both Jasanoff and Fiorino. The timing and nature of public engagement is critical in this respect. Climate engineering has witnessed early upstream engagement, considered to be valuable if findings are to influence the development or regulation of a technology prior to the emergence of path-dependency (Stirling, 2008). However, this means that the processes of engagement themselves act to frame and define the object of deliberation, establish particular pathways for development and also tend to construct, craft or constitute the publics with which they engage (Bellamy and Lezaun, 2015). Bellamy and Lezaun (2015) suggest that early deliberation by the Royal Society (2009) and in Experiment Earth (Ipsos MORI, 2010) helped to define climate engineering as a coherent object and framed expectations regarding it. They argue that to deliver both substantive and normative purposes, subsequent work (including the deliberation on which this paper is based) then had to seek to 'un-frame' and unsettle those definitions and expectations.

The data on which this paper is based was collected as part of the Integrated Assessment of Geoengineering Proposals (IAGP) project, which was designed to address gaps in knowledge about the effectiveness and side effects of geoengineering schemes. The public dialogues were intended to enable systematic academic study of public perceptions of climate engineering and its risks. The project involved full-day facilitated deliberative workshops in four UK cities (Birmingham, Cardiff, Glasgow and Norwich), in 2012, each with eleven participants, recruited by a professional market research agency to be broadly reflective of the gender, age, ethnic, educational and socio-economic diversity of the UK and its constituent nations. Primary analysis of the dialogues has been published previously (Corner et al., 2013). This secondary analysis, applying a new set of analytical questions regarding justice issues, is a testimony to the richness of the deliberative process in eliciting expression of opinions, values and challenges, despite the relatively small number of participants. In common with all qualitative work of this kind, no claim to statistical representativeness can be made on the basis of a sample of this size. But the multi-layered data from small group deliberations such as this offers an equally important analytical lens to that provided by larger-scale (but necessarily less nuanced) quantitative studies.

Nonetheless, secondary analysis is uncommon, and not unproblematic (Capstick et al., 2015). In this case, basing the study upon secondary analysis arguably enables better exploitation of the rich existing resource of transcribed deliberative sessions generated within the IAGP project. The fact the data was not explicitly collected for the purpose of an analysis of justice considerations may even be an advantage in that the design and implementation of the engagement process cannot have been distorted to introduce deliberate framing effects. Although secondary analysis typically raises a question of 'fit' between the data and the questions asked of it (Hammersley, 2010), in this case the research question established by the IAGP is clearly broad enough to encompass issues of justice and responses from publics, and the material gathered rich enough to address them. However, in this context, the relative absence of explicit justice issues from the initial research design raises a risk that unconscious framings might have been introduced by facilitators unprepared for these issues. To help address this, facilitators' contributions were coded (distinctly) as part of the process, and no reasons for concern were identified.

Secondary qualitative analysis can also raise concerns about interpretation (Hammersley, 2010), recognising that however well recorded or transcribed, those undertaking interviews or facilitating deliberative processes are exposed to a richer experience of communication which can supplement – or in rare cases, contradict – the words used, and can therefore, theoretically, better interpret the material. This issue is not considered significant in the present circumstances, as most of the co-authors on this paper were present in the deliberative sessions. Thus in the writing and review process, there has been adequate opportunity to identify and rectify any possible misinterpretation of participant contributions, as well as obtaining the benefits that can arise from a detailed scrutiny of the transcripts by a new, more detached, reader (such as the identification of unintended framing effects). So in this case, secondary analysis of qualitative data of this nature is considered not only appropriate but desirable.

The original deliberative sessions were designed with consideration of the need to articulate systems thinking, and to provide balanced information and policy framings in ways that open up spaces for reflection and deliberation and solicit a broad spectrum of opinion (a philosophy towards public engagement described at greater length in Pidgeon et al., 2014). The central approach taken was to encourage participants to raise concerns and questions about climate engineering, as well as reflecting on its potential benefits; and to constantly probe to unpack participants' reasoning behind their questions and concerns. Climate engineering was discussed as a potential response to climate change, following discussion of mitigation and adaptation. Although not constituting as extreme an 'unframing' exercise as that of Macnaghten and Szerszynski (2012) who did not even describe geoengineering as a response to climate change, this served to reposition climate engineering as one of a series of possible valid responses, rather than as a singular novel approach. Four specific climate engineering techniques were described in some detail to help stimulate discussion and to illustrate the diversity of techniques falling under the rubric of climate engineering. These were: stratospheric

aerosol injection, marine cloud brightening, direct air capture and biochar. Although the discussions mainly addressed climate engineering in general, in the following we note when participants' comments refer to specific technologies.

In the design and facilitation of the process, care was taken to not introduce potentially misleading framings identified in previous public engagement (Corner et al., 2013). However, in the final session of each day, a number of quotes representing specific perspectives (selected from existing academic and grey literature sources) were introduced to ensure that all the groups had considered the same broad range of possible responses. The nine statements reflected common academic and media framings. These included three statements of clear relevance to justice concerns: "*Some countries will see geoengineering as an excuse to avoid reducing their own emissions and that's* not fair"; "*How do we expect everyone to agree on something like geoengineering? If some countries think one thing and other countries think something else then it will just be the rich and powerful countries that get to decide*"; and, with particular respect to moral hazard: "*If we could come up with a geoengineering answer to this problem then we could carry on flying our planes and driving our cars*". In the process of analysis, we have been careful to distinguish views raised before the introduction of this material from those that followed these prompts.

The discussion in this paper is based on qualitative thematic analysis of the transcripts assisted by using the data management software Atlas Ti; and in particular on an analysis of the co-occurrence of different themes and opinions amongst the 44 participants. The coding process was focused on those aspects of the transcripts perceived as relevant to justice, although all the material has been closely read multiple times. Any material expressed by the participants in terms of justice or fairness was included, alongside material relating to justice issues identified by philosophers and ethicists working on climate engineering, and material that reflects concerns or issues raised by activists and publics on other environmental justice topics.

In line with good practice as suggested by Friese (2014), coding categories were primarily developed empirically from the transcript material, subsequently compared to theoretical concepts, and further developed in an iterative process as recommended by Pidgeon and Henwood (2004). Co-occurrence of different themes and categories was assessed using the Atlas Ti co-occurrence utility, which highlights the physical proximities of concepts in the text, and by systematic manual checking of the identities of speakers.

The source material is still highly relevant to current climate policy, given renewed interest in climate engineering, and especially CDR, following the Paris accord (Nicholson and Thompson, 2016; Williamson, 2016) and the persistence of justice–related disagreements over climate policy in recent years. While our findings are drawn from UK-based public engagement, they are of wider relevance both to other nations involved in geoengineering research and development, and to global climate policy. Understanding perceptions of justice in nations like the UK is globally significant as the UK is amongst the nations that are understood – on philosophical grounds – to *owe* duties of mitigation and compensation.

4. Justice issues identified in the dialogues

Various justice concerns were raised or endorsed in all groups in the IAGP dialogues, by a wide range of participants. The following sections introduce the most persistent and prevalent concerns identified, explore how they were raised, unpack the possible meanings, associations and motivations involved, and identify conceptions of justice these might reflect. By their nature, quotes are inevitably selective, but those presented here illustrate relevant aspects of the discussions. Typically, the selected quotes were either not contested within the discussions, or more often, reflect several participants speaking in similar terms. The quotes given are identified by the city and whether the speaker was male (M) or female (F) and for those directly related to issues for which prompts were given, whether the comment was made before or after the prompt (pre-prompt, post-prompt).

The following sub-sections consider in turn four different aspects of justice: the concept of 'moral hazard', the notion of 'environmental dumping', discussions around vested interests and the idea of fair governance.

4.1. Mitigation deterrent or 'Moral hazard'

First we examine discussion of the prospect that some countries, groups or individuals may be motivated to reduce mitigation by the actual or apparent availability of climate engineering. Such a mitigation deterrent effect (Morrow, 2014) or 'trade-off' between climate engineering and mitigation (Baatz, 2016) could be serious for climate justice. The side-effects or uncertainties of climate engineering make it less able to reduce climate injustice than mitigation. Moreover, insofar as it might reduce the effort or expenditure on mitigation by those actors understood to have caused climate change, climate engineering reduces the extent to which mitigation delivers corrective justice. Such mitigation deterrent can be described as a form of moral hazard. There is substantial debate over the exact nature and extent of the 'moral hazard' problem with respect to climate engineering and the best terminology to describe it (Hale 2012; Lin, 2013; Reynolds 2014; Morrow, 2014; Moreno-Cruz, 2015; Baatz, 2016) but few if any scholars or commentators reject the existence of the phenomenon.

Moral hazard can be inherently an issue of justice where the outcome is a transfer of risk from those making the decision to others. In the case of climate engineering, moral hazard typically implies shifting climate risk onto those most vulnerable to climate impacts, and especially onto future generations, by reducing or delaying mitigation. In the following we use the term moral hazard as a broad category encompassing a variety of logics for mitigation deterrence, and present material that illustrates the plural and inter-related public concerns in this respect. Understood in this way, moral hazard featured in the group discussions on both CDR and SRM approaches in statements such as the following:

> *"I think [geo-engineering] would act as a smoke screen . . . . it lulls us all into a false sense of security." M, Cardiff (pre-prompt)*
>
> *"it could be a cop-out as well. For not doing things on a day-to-day basis. Because it doesn't matter, because 'Hey, we're going to take all that from the sky and we're going to put it into the ground in 50 years' time, so where's the problem? . . . [But] most geo engineering technologies do not yet exist; will they exist?" M, Cardiff (pre-prompt)*

The potentially demotivating effect of climate engineering was recognized by participants, and linked to uncertainty about its practical deliverability, but not explicitly expressed as an issue of inter-generational justice. However, in other ways, participants expressed significant concerns for future generations with respect to both climate engineering and climate change more generally. These arose both in cosmopolitan forms – of concern for generic future people – and more communitarian terms – of concern for children or grandchildren.

> *"I think it's our responsibility, we're only custodians, we're only here for a short period of time why should we ruin it for every generation to come." M, Cardiff*
>
> *"now I've* got three kids of my own I think completely differently and it's about creating a future for them." M, Birmingham

Reflecting findings regarding energy practices (see Shirani et al., 2013), future concerns framed in communitarian terms were substantially more likely to be expressed by participants who at some time in the session had identified themselves as parents than by other participants.

The implication that moral hazard might be unfair to future generations was perhaps taken for granted. But concepts of fairness were more directly and explicitly mobilized in the second, and more commonly raised dimension of moral hazard: that of countries or groups using climate engineering as an excuse to unfairly avoid or renege on commitments or obligations to contribute to mitigation.

"you're kind of closing the stable door after the horse has bolted . . . if you had a system where you could deal with the carbon dioxide and reduce it, would that though then give some of the countries an excuse to just pour out more and more and more." M, Glasgow (pre-prompt)

"But it might make things worse. There might be then be new technologies come out because people think, 'Oh well, we've got this, we've got this geo-engineering here and that's going to fix all the problems so we can have extra planes or extra you know like something new!" F, Glasgow (pre-prompt)

"if [geoengineering] was put in place then some countries would use that as an excuse. They'd say 'there you go, it's in place, it's *doing the job; we don't have to worry about emissions and what have you.'" F, Norwich (post-prompt)*

Such obligations were seen by participants to arise not only on the basis of principles of 'the polluter pays' or historical responsibility, but on a broader sense of collective responsibility to mitigate, so encompassed also developing countries and emerging economies, as well as more 'usual suspects' like the United States of America and Russia. Some participants actively voiced concerns that it would be unfair to expect the UK to act if other countries did not – a view that extended even to the conduct of climate engineering where that was considered.

"I think what both of you two are exactly saying is that what's the point in us doing it [mitigation] if the whole rest of the world isn't going to do it." M, Cardiff (pre-prompt)

"it's good that everyone benefits, but why should the UK just do all, all this hard work [to develop geo-engineering], and no one else bothers." F, Glasgow (pre-prompt)

Amongst these publics, 'I won't if you don't appear to be a widely applied rule of thumb for fairness, with an implicit common understanding that free-riding, or benefiting from something to which one has not contributed, is unfair. Concerns identified under this heading were often linked to support for a normative view that climate engineering – even where it was considered attractive – should not be permitted to reduce or replace mitigation activity:

"I think mitigation is the key to it, you know, you've got to start somewhere and you start with mitigation and keep it going . . . mitigation is definitely on the cards for keeps". F, Glasgow (post-prompt)

"Some research on this is sensible but [I] wouldn't want this to take money away from mitigation". F, Norwich (post-prompt)

More recent research has distinguished a political moral hazard from a personal form: in the former politicians, governments and other organisations are seen as vulnerable to the temptation to backslide on mitigation if climate engineering appears plausible, while in the latter it is individuals who are affected. Corner and Pidgeon (2014) suggest the former is both more likely and more serious. Wibeck et al. (2015) suggest that concerns about political moral hazard predominated in their focus groups. Our data supports a similar interpretation. Participants raised concerns about moral hazard in all groups, and with some exceptions most participants saw it as a serious risk. Moreover, while they appeared to distance themselves from the possibility that they personally might reduce mitigation because of climate engineering, they often expressed concerns that others, especially politicians, might be tempted, echoing the public scepticism Capstick and Pidgeon (2013) found regarding the political system's capacity to deliver effective climate policy.

"What I don't like the idea of is that if measures come out to help us in the medium and long term that people then make the decision that sod it we won't bother doing preventative measures . . . we'*ll just produce as much carbon as we like . . . " M, Birmingham (pre-prompt, following discussion of aerosol injection)*

"I could see [politicians] kind of rushing in, 'This is the saviour of the planet and we're going to put it into place.' I mean I'm not just talking about our government . . . " F, Norwich (pre-prompt)

In one group, this fear of political moral hazard was illustrated by an analogy with tobacco tax:

" . . . they want people to quit smoking and the only way they'll stop it is to stop selling fags, simple as . . . then people can't smoke, you know what I mean? So it's the only way they'll do it but they won't stop because they sell so much and they sell so well." F Cardiff

On the other hand, a few comments seemed to imply something of a 'negative' moral hazard effect in which the risks and shortcomings of climate engineering stimulate a greater commitment to mitigation.

"[Actual geoengineering] would frighten people to death wouldn't it and it might get an internal reaction into talking about it and actually getting politicians to make decisions and get things done." M Birmingham (pre-prompt, following discussion of aerosol injection)

However on close reading of the transcripts most of the comments implying an incentive to mitigate appear to refer more generally to learning about the seriousness of climate change at the event, and not explicitly to climate engineering.

"I mean it's opened my eyes to how serious· · ·?I knew it was serious but the fact that we've gone into this where we're looking at reflecting sunlight and you're thinking, 'Well it's a bit closer than I thought really." F, Birmingham (pre-prompt)

We might also sound a note of caution regarding the personal commitments expressed in such groups. Past experience with deliberation suggests that participants may express ideas that are thought to be socially deviant by attributing them to unspecified others. In this case we must recognise the possibility that participants who in reality might be tempted to avoid more inconvenient forms of mitigation (especially if others were not doing them) – the social form of moral hazard identified by Corner and Pidgeon (2014) – could be loathe to admit that in a group setting discussing responses to serious climate change, but might well rather express it as something 'others' might do.

Nonetheless, like many climate engineering scholars, these publics clearly identify and fear the prospect of moral hazard. However, they interpret it as an issue of justice more in terms of free-riding than as an unjust transfer of risk. This perhaps strengthens concerns that free-riding might justify a fear of moral hazard (Hale, 2012); or contribute as a strategic deterrent to mitigation from an economic theory perspective (Moreno-Cruz, 2015). Avoiding moral hazard raises serious governance challenges (as previously highlighted by Parkhill et al., 2013), for instance: how to ensure that resources allocated to mitigation (including such diverse things as research budgets and parliamentary time) are not diverted, or that arguments for lowered effort on mitigation

as economically rational risk adjustment do not obtain political traction.

4.2. Distributed impacts: environmental dumping

In modern Western society, questions of justice often focus upon the distribution of harms and benefits. Participants raised distributive concerns but in unexpected ways. Although the uneven or unfair distribution of climatic effects, such as changes in rainfall patterns arising from climate engineering, is the main way in which climate scientists have engaged with justice concerns, it did not feature strongly in the discussions. This is perhaps more because the distributed nature of such implications is not immediately obvious when climate engineering is presented as a response to climate change designed to ameliorate the rise in global temperatures, rather than a lack of concern for groups or nations vulnerable to such effects. However, and somewhat unexpectedly, participants typically swiftly identified the possibility of unfairly distributed impacts from CDR techniques, drawing analogies with the dumping of undesirable wastes (or polluting processes) on poorer populations, particularly in developing nations. Such concerns arose with respect to both biochar and direct air capture.

> *"But I can just imagine that's what they'll do. So they get all the CO_2 and then, what, give it to a poorer country? So dig a hole, we'll give you a couple of million . . . " F, Glasgow*

> *"if it's lucrative for companies to be involved in it, they'll always do what they can for the countries that have got money . . . and you'll end up with the less developed countries being used as the dumping grounds . . . because that's how they'll make the money." M, Glasgow*

> *Participant 1: "we haven't got the land to place them on but we could produce [geoengineering technologies]. . . .*
> *Participant 2: 'Yeah but then we'd send it to some poor country like we send all our rubbish . . . you know all the stuff that we can't* recycle it all goes off to India or China or somewhere and it's dumped there.' *Discussion, Birmingham*

The phenomenon of environmental dumping is widely discussed in the environmental justice literature especially in the USA where research suggests that communities of colour are disproportionately exposed to environmental hazards, and institutionalized racism is seen as a contributing factor (Bullard, 1990; Shrader-Frechette, 2002; Walker, 2012). However, it has not previously featured strongly in policy and public discourse in the UK, despite efforts by some UK NGOs such as Friends of the Earth and the Environmental Justice Foundation to highlight such problems, so the prevalence of this frame was unexpected.

The focus on CDR perhaps reflects a greater *tangibility* of concerns over the risks of carbon storage, which were raised as a particular future uncertainty (a risk distributed over time as well as space), and primarily, though not exclusively with reference to direct air capture approaches.

> *"I don't like the idea of like carbon dioxide could be stored underground or in the ocean, so you're just creating problems for the future for that." F, Birmingham*
> *"what's the effect of storing it underground and what are the effects of storing it in the ocean (murmurs of agreement) because I'd really like to know what impact it actually has . . . Is it a ticking time bomb?" M, Birmingham*
> *"Well, what damage are the chemicals going to do if it's going to remove the carbon? And when would they find that out? And then just like we were all saying earlier, if it could be in another 150 years people are like 'Why did they do that?' because this has now caused another problem." F, Glasgow*

Although concerns about storage also appear in deliberation about carbon capture and storage (CCS) related to energy technology (Butler et al., 2013), it does not appear that greater familiarity with carbon storage (in comparison with unfamiliarity with SRM) was the cause of concern here, as only one or two participants expressed any awareness of carbon capture and storage proposals associated with power plants in the UK. It was however noticeable that terms such as 'chemical' or 'gas' raised concerns more generally (not only because particular groups or communities might be exposed to them), perhaps reflecting their status as everyday risks in domestic and wider settings.

> *"You see that's what I was thinking I'm* thinking like gas because gas like gas in the cooker that can then explode, that's why I'm not sure what could that then explode and you'*d think, 'Oh my God, there'*d be gas everywhere and . . . ' do you see what I mean?" F, Norwich
> *"Especially when we came up with the thing about geo-engineering, using chemicals, you know, as a solution. Chemicals . . . don't sound very good, you know". F, Glasgow*

This area offers a good illustration of the complex processes by which publics mobilize existing analogues and concepts to 'make sense' of a new and unfamiliar topic (Marcu et al., 2015; Wibeck et al., 2015), and in turn expose underlying values and principles. Such concerns also indicate that with more comprehensive initial information about the mechanisms and distributed implications of solar radiation management, the prospect of its negative localized side-effects being 'dumped' on the poor and powerless might equally be expected to raise public concerns, albeit involving different analogues.

Worries about the threat of environmental dumping did not however rely on an explicit link to concerns about the unfair distribution of power. In these engagement events, only a minority of those concerned about the excess influence of the rich and powerful made such a connection. Yet suspicion of vested interests was widespread (as we outline in the next section), and we suggest that this is another example where the underlying connection was effectively 'taken for granted'.

4.3. Suspicion of vested interests

The transcripts largely reveal conceptions of justice that are rooted in real-world context and experience, rather than in abstract justice theories (or in perceived characteristics of the climate engineering techniques considered). For instance, participants in all the groups expressed concerns about the influence of the rich and powerful on decision-making, and about the implications of corporate involvement and the profit-motive for climate engineering, often citing past experience and what we might describe as 'commonplace knowledge' about how society works. In other words, echoing Parkhill et al.'s findings (2013) of public support for innovation coupled with fears that commercial interests might override the good intentions of scientists, our participants were concerned that climate engineering, like other responses to climate change, might be driven by vested interests rather than by scientific assessment of the climate problem.

> *"you get to know that whatever you say, whatever you think, isn't going to make the slightest bit of difference because you're in the hands of politicians and big business and if people are making a lot of money they don't care if they're polluting the planet." M, Norwich*

Participant 1: "so your Gates and Branson couldn't do it without permission; they can't just decide to start doing it . . .
Participant 2: 'Well, I dispute that. I think they can decide what they want, because at the end of the day they've got access to people in power'. Discussion, Cardiff

The prospect that companies perceived to have profited from climate change might subsequently profit from climate engineering appeared to be felt as especially unfair. This perhaps indicates underlying corrective or even retributive conceptions of justice, which would call for those benefiting from past harms to pay compensation or even be punished rather than further rewarded (Farber, 2008; Walen, 2014):

"You just mentioned [commercial oil company] there, first they're going to make mega millions producing oil and stripping the world resources and now they're going to make mega millions, protecting it, you know, it's going to be the same companies that are doing it." M, Glasgow (with reference to direct air capture)
"So my biggest fear around all of this is if a private corporation was to develop . . . it only looking at the financial gains and all the trappings that come with that? Or is this about, 'well you know what, we've made tons of money out of what we've done in the past; we've dug for oil, we've found whatever, whatever and we've made absolutely shed loads of money. Now we're in a position where we're having a huge impact on our overall environment here's what we're going to put back in terms of our profits from previous years into developing ideas and what we're going to do with those ideas is share them.' If those companies or those entities were to be saying that I'd be saying . . . yeah power to them let them go ahead and develop. But we all know sitting here if a private corporation goes ahead and develops it's about monetary return." M, Birmingham

Significantly, some participants endorsed a view that climate engineering should not be 'for-profit' at all. Even amongst those who apparently accepted for-profit climate engineering in line with a standard, understood model of progress in which commercial interests advance and develop applications of science, such acceptance was typically grudging.

"I have to say, anyone who's going to be doing it for money, and if a profit can be done on to it, they should not be involved in it whatsoever." M, Glasgow
"Trust more in organisations who don't have a hidden agenda, for example, Greenpeace, rather than profit-driven companies . . . So anyone making money on it, you know, or we don't know but we'd assume that, you know, that's what their target's going to be, making money, and they can cover facts, hide certain things, whereas . . . a non-profit organisation [would] be in it for the better interest and it's not just to make money and, you know, cover corners or cut costs or whatever, it's, they've got good intentions, basically." M, Glasgow

However, in some cases commercial involvement was described as the 'lesser of two evils' compared with taxpayer funding, which was seen as unlikely under current economic conditions.

"in the economic climate we're in, it's kind of the lesser of the two evils. that it's funded by people like that [companies], which may mean that the decisions are in privileged hands, but what's the other alternative? To take more public money that we don't have." F, Norwich

Strong conceptions of procedural justice may underlie the deep suspicions of vested interests expressed here. If widely replicated, such views could have serious implications for the design of appropriate governance and incentives should climate engineering be pursued (and we turn to these issues next).

4.4. Fair and responsible governance

Participants also engaged with other procedural aspects of justice, suggesting forms of governance that were seen to be fair and responsible, to be applied to any climate engineering technique. Much of this discussion was seemingly motivated by the perception of excessive influence by vested interests (in both research and potential deployment), and by concerns about the dominant role of certain countries in international climate governance.

"Which is always the same story, it's always the rich countries that decide in the long run. So ones that have got money and they can put it in, it's . . . their say, it really is." F, Glasgow (post-prompt)

Some participants feared such narrow decision making, although many felt it to be inevitable. Nonetheless a prevalent suggestion was that some form of multilateral, democratic and consensual decision making process for climate engineering would be needed – both at research and deployment stages.

"I mean you vote for governments why couldn't you ask everybody to, okay right well we'll tell you about this or what we're intending, have a universal vote?" F, Birmingham (pre-prompt)
"I mean if our country say, for example, our country came up with an idea then surely they just wouldn't do that without consulting other countries as well?" F, Birmingham (post-prompt)
"the United Nations has 193 members, you know, and it's your whole . . . it covers the whole globe so why can't it be managed by somebody like the United Nations? Not necessarily for profit." M, Cardiff (pre-prompt)

These findings echo and help elaborate those of Wibeck et al. (2015), Bellamy et al. (2014), Pidgeon et al. (2013) and Macnaghten and Szerszynski (2012), where participants called for effective governance and oversight. Here we also find support for particular tools of procedural justice, notably participation and transparency. In addition education was generally advocated, both as a foundation for better decision-making and for justice, in any response to climate change.

Participant 1: "If there's no money to be made it's about full disclosure isn't it? Because it doesn't benefit them to hold back on anything. . . .
Participant 2: "Would you want them to know about that they're even working on the idea?
Participant 1: "Yeah of course why not? The UN should be involved in it anyway because it's the whole earth isn't it and it's global." Discussion, Birmingham (post-prompt)
"I think yeah we all should really . . . Not just the rich and . . . I think everyone should have a say." F, Cardiff (post-prompt)

"I think it will come down to education and information, that you need to say to folk, 'Right, if you don't want to [protect the climate] for you, do it for your grandchildren and their children." F, Glasgow (post-prompt)

Such discussions of governance suggest that publics share concerns raised by scholars and ethicists that climate engineering governance would be extremely challenging if at all practical (e.g. Hulme, 2014; Hamilton, 2013; Rayner et al., 2013); that fair and responsible decision making in respect of climate engineering would require multi-scalar governance, and that without transparency and ongoing assessment, neither companies, nor politicians nor even scientists could be expected to act consistently in line with public interests.

5. Discussion: extent and conceptions of justice

This section first summarizes the extent to which justice issues were expressed in the dialogues, and the forms this took. It then discusses the significance of the publics' expressions of justice issues, and the possible conceptions that underlie them.

Justice issues appear consistently and repeatedly across the all of the discussions regarding the climate engineering technologies in the dialogues. Further, they appear in a rich diversity of forms and conceptions (albeit often subtle or even implicit and taken for granted, rather than explicit). However, the extent to which these public expressions directly reflect the distributional and utilitarian justice conceptions found in the scientific literature is negligible. There is more congruence with concerns for future generations and over moral corruption, raised by philosophers such as Gardiner (2010), and with concerns raised by social movements and environmental justice scholars such as Schlosberg (2007). Publics echoed both specific concerns highlighted in environmental justice, such as environmental dumping – which can be interpreted as a concern that poorer countries and groups are not afforded the same rights, protections and even recognition as rich communities – and the inherent diversity of environmental justice concepts rooted in the justice claims of social and environmental movements. Overall, issues rooted in lived experience, with concerns about power and procedure to the fore, appear more salient (if not necessarily of more concern) than more academic concerns such as the patterning of the impacts of engineered climates across space and time.

Capstick et al. (2015) note that, with respect to climate change, "people's understanding is culturally-embedded, and situated within broader conversations concerning such things as morality, justice, responsibility and trust" (p4). In this analysis we have found views on climate engineering that follow similar patterns. Justice issues are not typically the first or most frequent concerns raised by publics regarding climate engineering, but they are clearly relevant and appear to influence opinions whether implicitly or explicitly. Each of the issues highlighted above featured in at least three of the four dialogues, in every case raised or endorsed in some way by between a third and a half of participants. This is comparable with the proportion of the participants expressing concerns (discussed by Corner et al., 2013) about 'messing with nature' or the likely side-effects of climate engineering.

In these dialogues, as might be expected, justice concerns were expressed in context, reflecting established understandings of economic priorities, distributional politics and vested interests. This suggests that climate engineering is probably not being seen as *inherently* unjust because of any apparent essential characteristics of any of the specific technologies, but *potentially* unjust in the common ways the technologies might be deployed and governed, and the interests they could be expected to serve. In this respect, the findings therefore broadly support a view that climate engineering might achieve the form of conditional acceptance that has marked mitigation technologies such as nuclear power, and carbon capture and storage, as suggested by Corner and Pidgeon (2010). Like these technologies climate engineering is likely to stimulate continued demands for strong tools of procedural justice. Yet with the contextual and technological richness and diversity of climate engineering, such potential reluctant 'conditonality' has many possible dimensions, and arguably, at least for certain SRM technologies, might even prove impossible to obtain within a democratic system (Szerszynski et al., 2013). Nonetheless, the expectation that in many guises it could – and probably would – reproduce the privilege of the rich and powerful (which is in turn understood as unfair), is likely to be shared widely enough to influence its political acceptability. Again, as in the cases of nuclear power and CCS, such reactions might help sustain widespread public suspicion or even resistance in many countries, raising particular concerns about climate engineering approaches with global impacts.

In the cases of CCS and nuclear, a key factor in conditional acceptance appears to be their integration into a coherent narrative of effective climate response (Butler et al., 2013). For instance when CCS is seen as somehow providing an alternative to, or slowing the progress of, decarbonization, opposition is more marked. This matches broadly with the way moral hazard concerns over climate engineering were expressed as a normative imperative in the dialogues reported here. Publics were clearly opposed to climate engineering being deployed as an alternative to decarbonization, but may be more sympathetic to its use within a coherent climate response package.

6. Conclusion

Carbon dioxide removal forms of climate engineering are already prevalent in scientific and political scenarios for limiting climate change to below a 2 °C global rise in temperature, and the aspirational goal agreed in Paris to work towards no more than 1.5 °C seems likely to also trigger renewed advocacy for consideration of solar radiation management. The role of justice in the formation of attitudes to climate engineering cannot be overlooked, any more than in other areas of climate policy. The expressions and conceptions of justice found in this study are complex and manifold, including international, intergenerational, distributional and procedural concepts. More detailed understanding would require carefully designed further deliberation, and continued efforts to unframe existing assumptions about climate engineering. The complexity revealed here suggests that politicians and researchers should remain wary of making simplistic claims about justice to try to promote a particular view on climate engineering or a particular form or technology. It is reasonable to explore the possibility that SRM might offer particular benefits to those most vulnerable to the impacts of climate change, as Keith (2013) for example, argues. But the overall implications for justice will depend on many other social, political and cultural factors as well as on the interrelated technological capabilities that emerge. The justice concerns we have identified were largely expressed as of general application to all the technologies discussed, although some of the implications of environmental dumping were clearly more directly applied to CDR methods. These findings suggest that efforts to redefine CDR as distinct from other climate engineering approaches would not reduce the breadth of governance challenges arising from demands for justice.

Moreover, these findings remind us that justice concerns are not only, or even primarily, the domain of academics and philosophers. Publics are engaged with the construction and understanding of justice and this paper has illustrated some of the dimensions they will use to judge or hold accountable those who bring climate engineering into being. Politicians and scientists will be at the sharp edge of procedures to determine the role – if any – for climate engineering within climate policy, and the design of mechanisms or institutions that might subsequently deliver it. Those procedures, mechanisms and institutions will not be developed in a vacuum: the attitudes of the relevant societies to inequality and mechanisms that produce and reproduce it over space and through time will inevitably influence the politics and practices of climate engineering research and development, just as much as the specific modalities and expressions of those politics and practices could reshape attitudes. Researchers and policy makers need to expand their climate engineering 'imaginaries' to include a better representation of publics and their justice

concerns – properly embedding the 'social' into sociotechnical systems and appraisals.

The evidence presented above suggests that perceptions of implications for justice, the nature of those involved in development and deployment, the incentives and safeguards they face, and the procedural mechanisms applied with respect to transparency, participation and accountability will all influence public reactions. More detailed – and internationally replicated – public engagement on climate engineering and its justice implications would appear essential if sound, well-informed and morally justifiable decisions are to be made regarding research or development of climate engineering.

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Paper 4: Framing out justice: the post-politics of climate engineering

Paper 4 suggests a number of ways in which discourses of climate geoengineering are rooted in an administrative, risk–management social imaginary and support the maintenance of (neo)liberal capitalist economies through 'post-political' framings that increase the risk of mitigation deterrence. It compares climate engineering with established responses to climate change in terms of the predominant narratives and frames used in media discourses. Based on review of previously published studies of CGE discourses it identifies four common frames: 'technological optimism', 'political realism', 'avoiding catastrophe', and a 'clean sheet' with respect to justice. It argues that the frames applied to CGE divert attention away from questions of justice that are more central to other climate responses.

It highlights competing climate change discourses of technological *Prometheanism*, *eco-modernization* and *green radicalism*. In comparison with climate change debate, it suggests that CGE mainly reinforces eco-modern and Promethean narratives rather than those of green radicalism. In particular, solar radiation management (SRM) enables *Promethean* narratives, while carbon dioxide removal (CDR) approaches match more closely with *eco-modernization*. In both cases there is a disconnect between the largely 'post-political', technological and managerial discourses of climate engineering and *green radical* climate discourses, which place questions of politics and justice more centrally.

Paper 4 also explores the implications of the 'clean sheet' framing which is common in CGE, but less so in broader climate discourses. It suggests that this framing is sustained and reproduced by post-political ideologies, silence about power, and persistent comparison of climate engineering with unabated climate change (rather than with the outcomes of other climate responses). It argues that a richer, and deeper treatment of justice would likely reject consideration of climate engineering as an alternative response, rather than as a supplement to mitigation and adaptation.

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Chapter 10

Framing Out Justice

The Post-politics of Climate Engineering Discourses

Duncan McLaren

This chapter compares climate engineering with established responses to climate change in terms of the predominant ways in which climate engineering is presented or framed in media discourses. It argues that these frames divert attention away from questions of justice that are central to other climate responses.

The chapter begins with a brief review of existing climate change discourses. Building on ideas derived from Dryzek (2013), it highlights competing climate change discourses of technological *Prometheanism*, *eco-modernization* and *green radicalism*. It then reviews the findings of previously published studies of climate engineering discourses to identify common frames: three of which are explicit—'technological optimism', 'political realism' and 'avoiding catastrophe'—and one implicit—the 'clean sheet' with respect to justice. These frames are compared and contrasted with those found in climate change discourses, highlighting ways in which climate engineering is adopting and reinforcing certain expressions of the eco-modernization and Promethean climate discourses.

The chapter also contrasts the ways in which solar radiation management (SRM) and carbon dioxide removal (CDR) approaches match these discourses, locating the former primarily within *Prometheanism* and the latter within *eco-modernization*. This further highlights the disconnect between the largely 'post-political' discourses of climate engineering and *green radical* climate discourses, which place questions of politics and justice more centrally, and largely reject climate engineering (at least as it is commonly defined and understood).

The chapter concludes with a philosophical analysis of the implications of the 'clean sheet' framing which is common to climate engineering, but not broader climate discourses. Some mechanisms by which this framing is

sustained and reproduced are suggested, including post-political ideologies, silence about power and persistent comparison of climate engineering with unabated climate change (rather than with the outcomes of other climate responses). The section argues that a richer and deeper treatment of justice than currently found in climate engineering discourses would likely reject consideration of climate engineering as an alternative to mitigation and adaptation, rather than a supplement (see Fragnière and Gardiner, this volume). It also suggests that better consideration of justice could helpfully illuminate key questions regarding the research, funding and governance of potentially appropriate techniques for climate engineering as part of a portfolio of climate responses.

As space is limited, this chapter necessarily simplifies geographic, cultural and disciplinary complexity. It focuses on public discourses—ways in which people discuss and make sense of a topic—in an effort to identify the most salient and prevalent approaches to the description and analysis of climate engineering across media and academic debate. Discourses are a largely coherent way of talking about an issue, a collection of narratives and storylines, viewed through specific frames—which may be issue specific or of broader application. Discourses around particular issues typically act to establish competing approaches and prescriptions for action. The chapter draws on a range of published content analysis, mainly focused on media coverage as the space in which academic, public and policymaker understandings are shaped and intersect. It highlights specific 'frames' deployed within discourses as 'a means of interpreting an object or issue' (Benford and Snow 2000, Gerhards 1995) or of establishing 'a particular construction of a problem and its solution' (Entman 1993). *Issue frames*, used by actors to promote a particular interpretation of an object or a problem, are distinguished from *master frames*, which tend to apply a broader ideological or discursive stance across a range of issues and which therefore may appear in multiple discourses (Dombos et al. 2012). Narratives and storylines are understood as processes that—deliberately or unintentionally—communicate the values inherent in particular framings and help to construct and reconstruct those framings. Discourses and frames are highly relevant to outcomes for policy and justice. They not only represent and mobilize particular attitudes to justice with respect to the topic at hand; they also typically embody existing power imbalances among those able to influence the discourse. Issues and framings that go unrecognized or are excluded can be as important as those that explicitly appear.

DISCOURSES OF CLIMATE CHANGE

Public debate frames climate change as potentially catastrophic, its solutions as primarily technological in nature and the challenge as raising

Table 10.1 Comparison of Key Discourses in Climate Change

	Prometheanism	*Eco-modernization*	*Green Radicalism*
Overview	Free-market neo-liberalism. Actively advocating disruptive technological innovation	Social democracy, with managed capitalism and markets. Positive but selective and managerial view of technology	Green and socialist politics, collectivist economics. Critical and precautionary towards technology
Discursive contests	Sceptical - - - - - versus - - - - Scientific		
		Reformist - - - - - - versus - - - - - - Radical	
Concepts of justice	Background: libertarian ideals of justice as desert	Part of debate: utilitarian and liberal models of justice, with limited redistribution	Foreground of debate: egalitarian ideals of justice
Application to climate change (Example)	May doubt the issue. Assumes that free markets and technology can solve any problem (Breakthrough Institute)	Accepts climate change as potential threat to capitalism, seeks reformist solutions through carbon markets and green investment (New Climate Economy)	Sees problem as symptom of (neo-liberal) capitalism. Seeks political, social and behavioural solutions (ETC group)

Note: These environmental discourses were first described by Dryzek (2013) as *Prometheanism* (and *economic rationalism*); *Ecological Modernisation* (and *green Keynesianism*) and *Green radicalism* (*green consciousness* and *green politics*) respectively.

important questions of justice yet somehow transcending or superseding politics (Anselm and Hultman 2014, Methmann et al. 2013). The dominant mainstream discourse (see also Table 10.1)—widely deployed in international climate negotiations—can be described as one of ecological modernization (Dryzek 2013), hereafter 'eco-modernization'. In its typical corporatist social democratic forms, eco-modernization offers a systemic response to catastrophic environmental threats while maintaining the essence of industrial capitalism. To address climate change it relies heavily on low-carbon technologies such as renewables, nuclear power and carbon capture and storage (CCS), alongside state intervention in both technological development and consumer behaviour.

Eco-modernization discourses deploy utilitarian and liberal concepts of justice. For instance, concerned that mitigation might harm existing economies or prevent future growth in poorer countries, they seek internationally coordinated climate action, under the rubric of 'common but differentiated responsibility'. But disagreements over the extent of historical responsibility and differentiated duties for mitigation and financing of adaptation continue

to hamper climate negotiations (Pickering et al. 2012). At national levels the distributional implications of climate policy measures, especially on adaptation, have often been critical to their design and success (Bickerstaff et al. 2013).

Despite the accepted significance of justice, eco-modernization however de-emphasizes political debate around climate change in at least two ways. Internationally, it seeks multilateral consensus around significant climate action as a universal threat, harnessing capitalism and globalization to deliver technological solutions—largely subjugating political differences to a dominant ideology of market capitalism. Nationally, it tends to individualize and depoliticize the problem, offering carbon markets and green consumption as solutions—which turns climate policy into a matter of consumer choice guided by economic markets. In this respect it has been criticized for its limited engagement with social justice and the distribution of wealth (Baker 2007).

Eco-modernization can therefore be seen as 'post-political' (Zizek 1999, Ranciere 2004) in multiple senses. As both the description and the critique of the late-twentieth-century ideological convergence around neo-liberal capitalism, 'post-politics' identifies and critiques the ways in which conventional democratic spaces of electoral and activist politics have been sidelined and disempowered. It highlights a series of shifts including a cultural individualization in which a focus on identity displaces concerns about class and a public debate in which risks feature more prominently than distribution. Climate change is understood as one of those risks, whose universal apocalyptic potential is paradoxically appropriated to defend corporate capitalism (Swyngedouw 2010).[1]

The central eco-modernization discourse is challenged from two directions, however: by a global Northern-centred discourse of denial and scepticism and a more Southern-centred one of green radicalism and anti-globalism.

In the global North, and particularly the United States, climate sceptics mobilize a 'Promethean' discourse to resist public action on climate change as an undesirable constraint on individual freedoms and free markets (Hoffman 2011a,b). While eco-modernization emphasizes the scientific basis of the challenge of climate change, Prometheans argue that *if* climate change is a problem, technological solutions will be found to address it. In such discourses, technological ingenuity gives humanity dominion over nature, with both the right and the capacity to control it (Dryzek 2013). Contemporary expressions of Prometheanism include the ideas of a 'good Anthropocene' advocated by the Breakthrough Institute (Asafu-Adjaye et al. 2015).[2] Like previous Promethean discourses these are aggressively post-political, placing both problem definition and solutions in an optimistic scientific and technocratic frame (Hamilton 2015). This leaves little space for questions of justice

(Collard et al. 2015) and assumes rather a libertarian ideal, in which inequality is accepted or celebrated as meritocratic.

Elsewhere, more radical discourses—such as 'eco-socialism' (Anselm and Hultman 2014) and 'green consciousness' or 'green politics' (Dryzek 2013)—are arguably the main challenge to eco-modernization. In green radical discourses, catastrophic climate change can only be averted—or survived—by transforming economic and political systems. Capitalism and corporate globalization are the problem, and solutions are seen in collective, politically driven lifestyle and behaviour change. Egalitarian concepts of justice are central to such discourses. Effective adaptation and mitigation is understood as necessarily being of a form that embodies justice, not just economically or technically efficient. Such perspectives are widespread, but generally subordinate to eco-modern approaches, except perhaps in some Southern countries, notably in Latin America.[3]

WHAT DISCOURSES DOMINATE CLIMATE ENGINEERING?

This section turns to the question of whether the same public discourses can be identified regarding climate engineering. It relies on secondary analysis of a corpus of discourse analyses, which considers the emergence and development of coverage of climate engineering in a range of media (Anselm and Hansson 2014a and b, Buck 2013, Loukkanen et al. 2012, Nerlich and Jaspal 2012, Porter and Hulme 2013, Sikka 2012, Scholte et al. 2013).[4] These analyses highlight some common and evolving discourses and narratives that echo some of those in extant climate policy debates. Systematic comparison of these analyses suggests a handful of highly persistent master frames which span otherwise distinctive climate discourses.[5]

Three *explicit* master framings can be identified from the climate engineering discourses: technological optimism, political realism and catastrophe-avoidance. Below (and in Table 10.2), each is outlined and its expression in climate engineering compared with that in broader climate discourses. The analysis also reveals one *implicit* master frame: the clean sheet. Subsequently, each of the frames is examined in more detail to identify contrasting aspects.

Technological optimism refers to the presentation of climate engineering as controllable, feasible and practical. The planet is often portrayed as a reparable machine or body, and the technologies as analogues of natural processes such as volcanic eruptions. This master frame includes both Promethean innovation and eco-modern technical managerialism.

Political realism claims that conventional approaches to mitigation and adaptation are incapable of responding swiftly enough—if at all—to the challenges of climate change. This 'post-political' master frame also appears

in different flavours, including eco-modern forms of 'pragmatism' that position climate engineering as a necessary Plan B, capable of apolitical delivery, and Promethean celebrations of entrepreneurial market-based technological 'solutions' that make restrictions on free markets unnecessary.

Avoiding catastrophe frames climate engineering as an—often *the only*—alternative to the catastrophic impacts of unabated climate change. This master frame appears in all forms of climate and climate engineering discourse, whether Promethean or eco-modern. In many earlier sources, it appears as an 'emergency' framing, supported by claims regarding the risks of climate 'tipping points'. In contrast, the risks inherent in climate engineering are typically portrayed as knowable and calculable, '*relative to the risks of unmitigated anthropogenic climate change*' (Porter and Hulme 2013: 347).

The prevalence of catastrophic portrayals of unabated climate change does not mean that climate engineering is necessarily portrayed as safe as well as practical. In fact, ambivalence about the technology (Scholte et al. 2013) and the idea that climate engineering is a distinctively 'post-modern' technology (Anselm and Hansson 2014a)—research into which is advocated despite serious risks—are notable in the analyses. Nonetheless, although debate and contestation are noted in these analyses, the typical conclusion is that there is a dominant discourse incorporating some or all of the main elements set out above.

Table 10.2 elaborates on how each of these frames appears in climate and climate engineering discourses.

The analyses considered here largely focus on explicit aspects of the debate. But what is unsaid or implicit can be just as important. In contrast with mainstream climate discourses, in climate engineering, justice is noticeable by its absence. Searching the climate engineering analyses for reference to justice, and related concepts such as fairness, equity, distribution, winners and losers, and gains and losses, reveals virtually no mentions, never mind discussion of its salience, even where reference is made to norms or ethics. Porter and Hulme (2013) identify 'morality' and 'justice' as among the three least prevalent of the frames they identified in written UK media coverage. In most other analyses, justice is occasionally hinted at, especially in procedural forms related to governance, but never takes centre stage. Buck (2013) also explicitly considers justice concerns, but finds reference to them in just 12% of print media articles and about twice that proportion of Internet articles. She confirms (2013: 176) that 'the justice issue is seldom considered; even when it was present, it was rarely the dominant frame. ... The antagonist in the dominant frames is CO_2, which mundanely threatens everyone, making questions of justice invisible.'[6]

This mechanism is perhaps the key way in which the emerging climate engineering discourse has implicitly framed justice out of the public debate.

Table 10.2 The Dominant Framings of Climate Engineering and Their Relationship to Expressions of the Main Climate Discourses

	Discourses		
	Promethean	*Eco-modern*	*Green Radical*
Master Frames	*In both climate- and climate engineering discourses*		*Climate discourses only*
Technological optimism	Dominant: Hubristic advocacy of high-tech, large-scale "solutions" such as nuclear fusion and SRM. Society is expected to inevitably adjust to technology.	Strong: Industrial technologies like CCS, electric vehicles and CDR are practical and essential. Risks of technology exist but can be negotiated and accommodated.	Weak: Social change is more important. "Appropriate" technology (renewables, passive buildings etc.) is endorsed, but "high-risk" technologies should be rejected.
Political realism	Strong: Post-political, technological solutionism. Politics is not only dysfunctional but undesirable—free markets are preferable.	Moderate: Politics must become managerial with consensual approaches between stakeholders and internationally within capitalist system.	Moderate: State politics is dysfunctional, but system change is possible and desirable. Individual and community action is required.
Catastrophism	Strong: Mobilized to support technological solutions and to sideline politics. In denialist variants the "catastrophe" to be avoided is state "takeover".	Moderate: Severity of impacts justifies serious interventions (and maintenance of core of industrial capitalism).	Strong: Severity of impacts justifies radical system change ("emancipatory" catastrophism)
Clean sheet	Absolute: No looking back. Future justice concepts go no further than desert and weak forms of procedural justice.	Strong: "End of history". Some regard for distributive justice looking ahead, and some concern for most vulnerable. Limited recognition.	Moderate: Even radical egalitarian rights-based approaches and "contraction and convergence" tend to downplay history. Broad recognition.

Note: The origins of the master frames in the climate engineering literature are detailed in Table 10.4 in the notes to this chapter.

Climate engineering advocates typically insist that mitigation and adaptation can no longer avoid dangerous climate change ('political realism') and thus that any harms arising from climate engineering should be contrasted with unabated climate change. Catastrophe therefore faces us all, and in this context, we are likely to consider distributional and other political questions to be of only secondary importance (cf. Swyngedouw 2010).

It is as though climate engineering proposals were emerging on a '*clean sheet*' where impacts of and responsibilities for climate change were not already unevenly distributed and contested. This implicit *clean sheet* is arguably the most distinctive part of the framing of climate engineering in contrast with climate change discourses generally. Its presence helps marginalize green radical framings of opposition and rejection, which appear only as a relatively weak alternative discourse with few active proponents (Anselm and Hansson 2014b, see also Markusson 2013). Although some scholars have attempted to integrate localized and small-scale approaches to climate engineering with socially just strategies for climate protection (Buck 2012, Olson 2012, Martindale 2015), such narratives are almost invisible in the public debate among green radical discourses that reject climate engineering (e.g. ETC 2010, Klein 2014).

There are also important differences in the ways climate change and climate engineering discourses apply the three *explicit* master frames. Detailed analysis suggests that the presentation of climate engineering—and especially SRM—within these frames often takes an exaggerated form that fits most closely with technological Prometheanism (as shown in Table 10.2).

In climate engineering discourses, *political realism* drives suggestions that climate engineering might be deployed unilaterally or by a small 'climate engineering club'. The difficulties of political action and the high leverage of the technologies are emphasized to justify avoiding collective negotiations, rather than to trigger a search for compromise. Some expressions of *technological optimism* in climate engineering discourses are also arguably more extreme. While leading CDR technologies [such as Bioenergy with CCS (BECCS) or Direct Air Capture of carbon dioxide] and their dependence on carbon markets closely reflect the managerial styles and industrial technologies of eco-modernization, SRM implies extreme Promethean hubris regarding human capacity to understand and control complex Earth systems.

Finally, in their treatment of *catastrophe*, climate engineering discourses—especially those advocating SRM—often emphasize urgency. They deploy an 'apocalyptic' form of catastrophism (Asayama 2015), designed to legitimate a 'techno-fix' to protect industrial modernity, as opposed to the 'emancipatory' and openly political form used by green radicals to argue for socially disruptive ways of responding to climate change. An apocalyptic threat potentially justifies 'securitization' of an issue and deployment of 'exceptional',

even military measures' (Corry 2014). While Prometheans denigrate much state intervention, they are, however, remarkably supportive of state action and expenditure on national defence and security. Consideration of climate engineering might therefore further enable climate change to be incorporated into a Promethean discourse that has previously sympathized with a sceptical perspective motivated by 'small-state' political ideology.[7]

In summary, the discourses of climate engineering are often reminiscent of mainstream climate discourses, especially in their central eco-modern form, but with all three *explicit* framings—political realism, technological optimism and avoiding catastrophe—exaggerated to a significant degree, in particular when discussing SRM. The chapter now turns to focus explicitly on the contrasts between SRM and CDR in these discourses.

CONTRASTS BETWEEN SRM AND CDR

This section elaborates on the differences between framings of CDR and SRM identified above and identifies some implications Table 10.3 summarizes this analysis.

Analyses of general media discourses typically find little distinction between SRM and CDR (e.g. Porter and Hulme 2013), although specific techniques—notably stratospheric aerosol injection (SAI) as a form of SRM and ocean iron fertilization (OIF) as a form of CDR—are often discussed. SAI has been widely positioned as *the* exemplary climate engineering technology since the Royal Society report (Shepherd et al. 2009), while OIF has seen some active experimentation and controversy over governance. Both fit the broader narratives of high-tech natural analogues, with high leverage

Table 10.3 Application of Key Climate Discourses in Climate Engineering

	Prometheanism	*Eco-modernization*	*Green Radicalism*
Attitude to climate engineering	Supportive of research and development	Supportive of research and selective development	Largely opposed to research and development
Application to SRM	Supportive, even in some cases as an alternative to mitigation	Seen as last resort, requires research and careful risk assessment	Opposed: even to extent of preferring adaptation in some cases
Application to CDR	May be supportive if low-cost. Likely to oppose subsidies	'Negative emissions' are important in managerial approach. Fits with carbon price/markets	Opposed to large-scale technologies such as OIF or industrial-scale BECCS and afforestation

and scope for unilateral action, and considerable uncertainty about the risks involved. These two technologies therefore arguably suit media agendas, in which some controversy is desirable.

There are other generic similarities between SRM and CDR: both carry risks of moral hazard, for example. Nonetheless, much scholarly and policy work—as well as noting the diversity of techniques in both categories—has begun to construct narratives that distinguish rather than conflate SRM and CDR (McNutt et al. 2015a,b, Shepherd et al. 2009). SRM is often described as rapid, low cost, high risk and (perhaps) less natural. CDR is slow, high cost, low risk and (to some degree) more natural. These distinctions have significant implications for the ways in which dominant discourses affect the approaches. In these rather caricatured forms, CDR would appear to better match eco-modernization discourses, and in fact, the New Climate Economy initiative (NCE 2014)—an excellent example of the contemporary eco-modernization discourse—already encompasses support for improved management of land-based carbon sinks.

On the other hand, SRM—and especially SAI—fits more neatly in technological Prometheanism. If we recognize the Promethean discourse as rooted in part in climate scepticism, it is easy to see why. SRM has already been advocated as the best 'insurance policy' if climate is an issue by sceptical Prometheans such as Dubner and Levitt (2010) and Lomborg (2009). In this form SRM could performatively define an acceptable 'climate problem' in which the capability to control climate outcomes can be sought even without acknowledging a link with CO_2 emissions, and the 'solution' does not involve large-scale intervention in free markets or restrictions on the use of fossil fuels. CDR, on the other hand, remains inextricably linked with CO_2 emissions, even if its costs can be somehow managed by incorporating it into markets, for example in carbon utilization.

Yet as a rapid and high-leverage technique, SAI is not just a potentially marketable insurance policy but also appears to fit catastrophic and emergency framings—allowing humanity to respond when (and only when) it is clear that climate change is a clear and present danger. Advocacy for SRM research by high-profile climate scientists such as Paul Crutzen, David Keith and Ken Caldeira (Caldeira and Keith 2010; Crutzen 2006; Keith 2014) is arguably a product of their belief that such severe impacts are already otherwise unpreventable (in contrast to Baatz and Ott, this volume).

In eco-modernization discourses, a similar catastrophist framing—in the form of analysis showing the impracticality of achieving the 2°C target without negative emissions—is being deployed to support arguments for urgent investment in and development of CDR techniques. But at the same time, the incorporation of CDR in climate models (typically in the form of BECCS) helps sustain the claim of eco-modernization that climate change

can be tackled through low-carbon technology and carbon markets, without overturning capitalism.

CDR might also feature in green radical discourses, but only in certain forms. Ocean iron fertilization is seen as Promethean in its hubris, while at a large scale, BECCS and even biochar are rejected because they are seen as industrializing forests (ETC Group 2010). However, some techniques, especially forms of soil carbon restoration or localized enhanced weathering, might be perceived as acceptable 'no-regrets' options within green radical discourses (Martindale 2015).

The next and final section turns to the central question of the chapter: what are the implications of these Promethean and eco-modern discourses and their post-political, market-based, technological and solutionist framings for justice?

IMPLICATIONS FOR JUSTICE

We saw above that the implicit 'clean sheet' frame is prevalent in climate engineering discourses, but not in climate change discourses in general. This section outlines three broad implications and highlights some critical mechanisms by which they are reproduced in the discourses. It argues that creating a clean sheet erases historical obligations; detracts attention from power and vested interests, and the ways in which future generations' options might be constrained; and insofar as justice appears at all, implicitly inscribes particular cultural and ideological concepts of justice in the discourse.

Historical obligations related to climate change are not uncontroversial but might arise in diverse ways and forms. Fundamentally, many proposals for responses to climate change seek to respond to historic injustice. Arguments for 'contraction and convergence' (Mayer 2000), 'greenhouse development rights' (Baer et al. 2010) or repayment of a 'climate debt' (Athanasiou and Baer 2011, Blomfield 2015) rest on the historically disproportionate use of fossil fuels and carbon sinks by some nations and groups. Disproportionate resource use has fuelled a process of uneven development in which wealthier countries now enjoy much greater capacities and financial resources to undertake mitigation and adaptation, and in which poorer countries' greater vulnerability to climate impacts is exacerbated by the legacy of colonialism and underdevelopment (Adger et al. 2006). Moreover, the structural processes that have enabled uneven development continue to exist (Blomfield 2015).

In current climate politics, these concerns have fuelled debate over the extent and financing of relative obligations to reduce emissions, maintain carbon sinks, support adaptation and enable migration and relocation, among others. Southern nations perceive a twofold injustice—first that the impacts

of climate change harm them disproportionately, and second, that in pursuit of global mitigation, their capacity to develop based on the use of fossil fuels will be unfairly curtailed (see, e.g. Luwesi, Doke, and Morrow this volume). As a result, those disadvantaged by carbon-fuelled underdevelopment have sought forms of compensation or rectification from the winners—rooted in corrective or restorative, as well as distributive, concepts of justice. All these understand the growing impacts of climate change as—to a major degree—the product of historic and ongoing unfairness in the distribution of fossil fuel use and carbon emissions.

In contrast, by emphasizing the ineffectiveness of political solutions, climate engineering discourses deemphasize historical responsibility. Comparisons with scenarios of unabated emissions growth, rather than more realistic trajectories of partial mitigation, portray any negative distributional effects of climate engineering as insignificant in the face of the catastrophic outcomes of unabated climate change. Moreover, because these scenarios are presented (within the 'averting catastrophe' and 'political realism' master frames) as an inevitable context for the consideration of climate engineering, rather than a morally loaded choice, this also implies that the distributional consequences of unabated climate change are somehow of less moral consequence.[8] The construction of climate engineering models and the narratives derived from their findings thus deflect attention from the historic causes of climate injustice. The more it is presented as impractical and politically unrealistic to avoid a high greenhouse gas world, and the more focus is drawn to technological means of avoiding the extremes of climate impacts, the less attention is paid to any moral obligations arising from historic emissions. Compensatory obligations on historic emitters do not appear in the public discourse.[9] Even a weak obligation on developed nations to fund mitigation and adaptation in poorer ones—based in the ability to pay (Caney 2010), rather than any confession of culpability or complicity—is, in SRM advocacy, potentially traduced into a push for a 'lower cost', economically more-efficient alternative whose higher risks rebound on the victims of climate change. In other words, SRM is presented as more acceptable precisely because it imposes fewer financial costs on the very countries responsible for the majority of past emissions.

Not only is state responsibility largely invisible, but so is corporate responsibility and power. In contrast to mitigation discourses, in some of which proposals seek to focus obligations on the largest corporate polluters and extractors of fossil fuels (Klein 2014, Tickell 2008), in climate engineering discourses the power of the (corporate and national) fossil fuel lobbies—built on a history of colonialism and resource extraction—is typically concealed. The post-political nature and technological optimism of climate engineering narratives also pushes questions of power and interests further into the background.

These framings are reproduced in discourses presented predominantly by scientists and experts. In her study of geoengineering in print news media from 1990 to 2010, Buck (2013) reports that 70% of assertions on the topic of geoengineering were made by scientists (of varying types), and only nine scientists were responsible for 36% of the assertions.[10] Eli Kintisch (2010) describes this small and highly influential group of mainly U.S. scientists as 'the geo-clique'. While the 'geo-clique' is likely as much a creation of media imperatives (and laziness) as it is any form of conspiracy, we must be alert to the risk that such a group might share ideological beliefs as well as scientific discussion. Insofar as in discourse making, statements from such a group are intermingled with those from libertarian, anti-regulation, climate sceptic lobby groups (Sikka 2012), we cannot ignore the possibility of a campaign to co-opt geoengineering as a tool to promote continued profits from fossil fuels, rather than as a potentially useful adjunct to accelerated mitigation.

In presenting climate engineering as a post-political technocratic solution, the discourses also understate the extent to which the current climate policy is an exercise of power with respect to future generations. Future people are particularly vulnerable to domination by the present generation (Smith 2012), and the deployment of climate engineering would strongly structure the choices available to them. Arguably, such domination of future generations is a case of failure of recognition: we treat future people as less than fully our moral equals. This is a particular problem if the development of climate engineering techniques also results in reduced action to mitigate carbon emissions, transferring risks onto those same future people. Yet the more climate engineering is understood and embedded as a means to maintain industrial modernism, the greater this risk becomes. This is a feature of both SRM and CDR. CDR enables further delay in mitigation in the belief that the same future CO_2 concentrations can be achieved by later action to draw down carbon from the air. Its inclusion in climate models allows eco-modernists to resist pressure from green radicals for accelerated emissions reductions. SRM similarly empowers those who would argue against mitigation as too expensive or ideologically undesirable.

In particular, any idea that fair and effective climate responses might instead require structural social change is pushed to the margins. Responses to climate change rooted in locally just and resilient communities (Hopkins 2008, Klein 2014) are typically ignored or dismissed as 'fuzzy thinking' (Keith 2014). At the same time, particular embedded and implicit ideological and cultural framings of justice are reproduced without explanation or question. In the Promethean discourse we see a narrow libertarian concept of 'justice' as freedom to pursue economic and commercial interests without fear of redistribution or expropriation. It is 'justice' as (rhetorical) equality of opportunity without regard for initial capabilities or endowments. In more eco-modern discourses the implicit concepts of justice are utilitarian, liberal

and sometimes distributional. Justice here is individualistic, but inequality and even exploitation—for example of indigenous communities resisting the conversion of forests into carbon storage plantations—are tolerated, or ignored insofar as they help increase aggregate well-being.

The climate engineering discourses, whether Promethean or eco-modern, exclude green radical concepts such as climate justice (Athanasiou and Baer 2011)—understood as equal rights to climate resources which therefore demand far deeper emission cuts than appear *politically realistic*, and recognition (Schlosberg 2009, Hourdequin, this volume)—with its requirement that we acknowledge differential vulnerability and different values systems in our approaches to procedural justice. More mainstream capabilities- and rights-based approaches are nodded to in some narratives, which feature calls for better public participation and consultation. But in practice the discourses are shaped by findings from research and scenarios constructed by climate modellers and academic experts with virtually no consultation of publics.[11] This privileges academic and modelling expertise (a form of epistemic injustice) and reconstructs justice, insofar as it appears at all, as something done to the public by elite institutions, rather than something with democratic, participatory and other procedural elements (McLaren et al. 2013).

In considering the framing-out of historical responsibility and climate justice, we have seen how the dominant climate engineering discourses are reproduced by comparisons with unabated climate change, by silence over power (which leaves the powerful also determining narratives and framings) and by the broader embrace of post-politics which excludes alternative framings and debate over them by appeals to singular 'objective' truths revealed by science and addressed by technology.

This is not to argue that climate engineering could not be deployed in ways that respect and even enhance justice (see Horton and Keith, this volume), rather that in the dominant framings such forms of deployment are unlikely. SRM's speed might allow near-term distributed climate impacts to be ameliorated (in contrast with CDR, which would have limited effect on climate outcomes for many decades), and some have argued that it could be targeted in ways that minimize negative distributional side effects (Moreno-Cruz et al. 2012) and ramped down to reduce termination risks. But such deployment implies global governance and effective complementary mitigation, neither of which features strongly in the framings identified here. Similarly, while CDR could conceivably be funded by historic high-emitting countries and/or companies—thus taking account of historical responsibility—the mainstream framings suggest that large-scale BECCS, with rich nations importing biomass to fuel power stations and using the CO_2 for enhanced oil extraction, would be a more likely model. This could exacerbate past injustices and worsen food insecurity (cf. Kortetmäki and Oksanen, this volume) by

transferring agricultural and forest lands from local and indigenous subsistence uses to serve the interests of rich-country populations for cheap energy (McLaren 2012).

In both carbon dioxide removal and solar radiation management variants then, technological and commercial feasibility structures current climate engineering debate, rather than justice considerations. *Technological optimism* about climate engineering serves to sideline questions about the distribution of the resources needed and about how to govern it fairly (rather than simply how to enable it). In contrast, political and social discussion of the design of mitigation and adaptation practices often brings justice into the centre of the debate. It is critical that future analysis of climate engineering examines the details of specific techniques, specific funding and specific governance mechanisms if justice is to be properly considered.

CONCLUSIONS: BRINGING JUSTICE TO THE CENTRE OF CLIMATE ENGINEERING

Overall, media frames typically imply that geoengineering would be practical and controllable, contrast it as a climate response with continued insufficient mitigation and describe the decision as one to be made in the face of potentially catastrophic climate change. They frame out active consideration of justice, presenting rather a post-political 'clean sheet' for climate policy.

These framings rebut any prospect of radical emissions cuts, denying 'climate justice', and exclude consideration of processes of underdevelopment, past responsibility for dangerous emissions and the role of vested interests in climate policy. They place decision-makers on the horns of a dilemma (where neither choice is fair or ethical), sideline procedural justice in favour of 'emergency powers' and downplay distributional implications, implying such a large-scale problem that 'we are all in it together'.

These discourses strengthen particular extant climate policy discourses, with CDR approaches to climate engineering matching well with narratives of eco-modernization and SRM fuelling a revived technological Promethean-ism which can even be embraced by climate sceptics. In comparison, climate engineering does not obviously support green radical discourses that are open to integrating narratives of climate protection with those of social justice, and more typically such discourses reject climate engineering. Indeed, insofar as climate engineering discourses spread, they bolster a trend of active depoliticization of the climate debate.

Looking both backwards and forwards in time, this chapter has drawn attention to both intra- and intergenerational consequences and obligations arising with respect to climate policy. It has argued that these must inform decisions about climate engineering. In particular, it has argued that climate

engineering's implications must be compared with those arising from effective mitigation and adaptation, not just with those arising from unabated climate change. Yet the discourses and framings set around climate engineering discourage such comparisons. Thicker and deeper treatments of justice are needed in climate engineering discourses. Such approaches would likely reject consideration of climate engineering as an alternative to mitigation and adaptation, rather than a supplement. Better consideration of justice could also helpfully illuminate key questions regarding the research, funding and governance of potentially appropriate techniques for climate engineering as part of a portfolio of climate responses.

Moreover, the power of narrative is itself also an issue of justice. Those who construct the narrative and set the frames determine the scope and terms of any debate. Different perspectives and epistemologies are not admitted, or at least not on equal terms. Yet for climate engineering we have seen that particular groups, disciplines and nations predominate in the discourses. This helps reproduce the discourses, alongside post-political ideology and the tendency to compare the effects of climate engineering only with unabated climate change. Wider public debate and deliberation would clearly be valuable in ensuring greater consideration of questions of justice.

In turn, this might offer the possibility of ending the domination of climate debate by discourses that sustain existing injustices—particularly those arising from the failure to recognize historic roots to injustice and the way elite lifestyles and cultures act to constrain capabilities in the global South. Otherwise it seems we face the prospect of climate engineering as an expression of neo-colonialism, extending domination by the global North, in contrast with the potential for fuller realization of human capabilities under a portfolio of climate responses shaped by a goal of climate justice.

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NOTES

1. Anselm and Hultman (2014) describe how neo-liberal managerial approaches to climate policy in Sweden (bolstered by the failed Copenhagen talks) resisted an opening-up of the debate in response to eco-socialist ideas of justice and redistribution

which had begun to penetrate the eco-modern centre-left discourses (bringing proposals such as work-sharing as well as green job creation) in the period 2006–2009.

2. The title of the Breakthrough Institute's 'Ecomodernist Manifesto' (Asafu-Adjaye et al 2015) is (probably deliberately) misleading, in that [as highlighted by critiques such as Hamilton (2015), Latour (2015) and Collard et al. (2015)] its market individualism, strongly antipolitical ideology and extreme technological hubris are more clearly aligned with Promethean discourses as described here and by Dryzek (2013). Its aim is presumably to convince the eco-modern mainstream to accept these more ideologically extreme positions.

3. In Sweden, Anselm and Hultman (2014) show that green radical narratives of equality also influenced the more mainstream eco-modern 'green Keynesian' discourses of the opposition centre-left parties.

4. These analyses are summarized in Table 10.4.

5. The application of the term 'master frame' is not intended to suggest that the climate engineering and broader climate discourses are completely separate; rather that within these discourses, the Promethean, eco-modern and green radical discourses can be distinguished, yet all display elements of the same master frames. It also seems likely that these master frames may also be reproduced in discourses around other issues such as food supply and the role of genetically modified crops.

6. The lack of justice in the public discourse does not mean it is also overlooked by academics. Scholars such as Gardiner (2010), Preston (2012), Smith (2012) and Burns (2013) have drawn attention to various aspects of justice among wider ethical concerns.

7. This discussion implies that climate engineering technologies are easily accommodated in industrial modernism. Although Anselm and Hansson (2014a) argue that climate engineering has a uniquely 'post-modern' character as a risky response to a modern hazard (a narrative of a 'double fear'), we might question the distinctiveness of climate engineering in this respect: arguably technologies such as nuclear power and genetic modification have also been promoted by Prometheans and eco-modernizers despite acknowledged risks. Moreover, as Anselm and Hansson themselves identify, a storyline of 'mimicking nature' has come to supplant that of the 'double fear' in an active attempt by advocates to 'integrate geoengineering into the logic of industrial modernity' (Anselm and Hansson 2014b: 117).

8. Methmann and Oels (2015) suggest a similar case in adaptation policy. In the presentation of climate change as an immutable fact, they argue, resilience discourses focused on climate-induced migration become post-political, depriving subjects of their rights, side-stepping questions of compensatory funding for adaptation and facilitating a shift of responsibility from the global North to the South.

9. This is broadly the case for academic consideration also, with the contributions to this volume from Habib and Jankunis, and Baard and Wikman-Svahn offering largely unprecedented efforts to consider SRM as a potential form of, or contribution to, historical recompense.

10. Buck notes that the 'loudest silence, so to speak, was from women' (p. 174). Space does not permit me to argue this further, but it would also seem reasonable to suggest a gendered preference for technological and politically negotiated responses to men and women respectively.

Table 10.4 Review of Consistent Themes in Climate Engineering Discourse Analyses

Source	*Technological Optimism*	*Political Realism*	*Avoiding Catastrophe*	*Coverage*
Loukkanen et al. (2012)	*Mechanisms*, *Health* & *Controllability* metaphors often carry such implications	*Controllability* metaphors such as "Plan B" are responses to limited political action	*War and Fight* metaphors, highlighting seriousness and potential need for sacrifice	Six sets of metaphors in 88 *NYT* and *Guardian* articles (2006–2011)
Nerlich and Jaspal (2012)	*Techno fix*: metaphors of planet as body or machine in need of fixing	Do not directly identify political realism, but highlight later emergence of "Plan B" narratives	The *argument from catastrophe* itself frames techno-fix metaphors	Metaphors in 91 popular science and other trade press articles (up to 2010)
Sikka (2012)	*Technological determinism*—a utopian belief in entrepreneurial innovation to provide solutions	*Market economy*—opposition to climate engineering is portrayed as opposition to economic progress and free markets	*Philosophical exceptionalism*—climate engineering as the "only option" for avoiding "catastrophic" climate change	Four discursive frames used by mainly conservative advocates of geoengineering
Buck (2013)	*Managerial* frame draws on "ecological modernization" and relative cheapness of climate engineering	Highlights absence of discussion of prospects for political or behavioural transformation	*Catastrophic* frame combines discursive elements of "crisis" and "inevitability"	one hundred and eighty one English-language print and online media articles (1990–2010)
Porter and Hulme (2013)	*Innovation* most prevalent frame: reflecting pro-technology stance of promoters such as Royal Society	In *governance* frame, frequent references to inevitability of climate engineering from "failed negotiations".	*Risk* framing highlights high stakes in unabated climate change	Seven issue frames in 70 articles in UK media (up to 2011)
Scholte et al. (2013)	*Techno-fix* (in 46% of articles). Technology the "key solution", nature "controllable".	*Pragmatism* (in 41% of articles). Climate engineering "is practical", but "current approaches" to climate are "failing"	*Avoiding catastrophe* (in 53% of articles). Climate engineering as perhaps essential or our "only hope" to tackle climate problems	Seven common frames in 181 English-language newspaper articles (2006–2011)
Anselm and Hansson (2014a and b)	Implicit *technological salvation* supported by *natural analogies* which emphasize the practicality of the technologies	*The failure of politics* and *cynical industrial fatalism* suggest no political option. "Emergency" frames also "depoliticize" the issue	*Double fear*: where climate engineering is risky but the alternative is catastrophe. In later material the *naturalism* frame ameliorates the riskiness of climate engineering	Dominant storylines in 1500 media articles between 2006 and 2013 in English, German and Scandinavian languages

11. The work of the IAGP programme (http://iagp.ac.uk/) is a notable exception, as deliberative public engagement (albeit only in the UK) influenced the research programme and helped inform the development of scenarios for comparative modelling evaluations of climate engineering technologies.

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Paper 5: The Humpty Dumpty problem: towards an ethics of repair in the Anthropocene

Paper 5 offers some alternatives to the dominant social imaginary through an examination of practical ethics or virtues of repair in potentially analogous arenas. It illustrates how principles or norms of care, integrity and legibility, and the integration of restorative justice would radically reframe ways of thinking about or practicing geoengineering.

It outlines ways in which CGE has been presented as a potential means to repair the climate system, highlighting narratives and metaphors that treat the planet as a body in need of remediation, a machine in need of repair and those which approach CGE as a form of restoration. It argues that these narratives are hubristic, functionalist, instrumental and utilitarian, and that they contrast starkly with conceptions, norms and practical ethics or virtues of repair found in more long-standing disciplines with deliberated and evolved pragmatic ethics. The paper explores ethics in five varieties of repair: reconstruction of historic buildings; remediation of human bodies; restoration of ecosystems; reconfiguration of cultural materials; and reconciliation of broken relationships. From this survey, the three interlinked virtues of care, integrity, and legibility are identified. These emphasize practices of repair that express attachment to the object being repaired (treating it rather as an active subject); respect its identity and inherent qualities; and maintain a visible narrative of its history, including the process of repair. Such a visible narrative contrasts markedly with the 'clean sheet' framing of CGE highlighted in *Paper 4*.

Subsequent to the viva, the version reproduced below was accepted for publication by *The Anthropocene Review,* subject to minor revisions.

The Humpty Dumpty problem: towards an ethics of repair in the Anthropocene

Abstract

With the power to break earth systems comes responsibility to care for them, and arguably to repair them. Climate geoengineering is one possible approach. But repair is under-researched and underspecified in this context. In a first attempt to establish basic principles for the obligations of repair in the Anthropocene, five disciplines of repair are briefly reviewed: reconstruction of historic buildings; remediation of human bodies; restoration of ecosystems; reconfiguration of cultural materials and artifacts; and reconciliation of broken relationships. In each case ethical practices and debates are described to help identify key themes and challenges in understanding repair. Three interlinked pragmatic ethics or virtues of repair in the Anthropocene are suggested: care, integrity, and legibility. Implications of for climate geoengineering, climate politics, and the possibilities of climate justice are explored. Climate repair is defended against objections that it would exacerbate a moral hazard effect, or frame climate responses as politically conservative.

Introduction

Humpty Dumpty sat on a wall, Humpty Dumpty had a great fall;

All the king's horses and all the king's men, couldn't put Humpty together again.

(Traditional British nursery rhyme[11])

Both materially and discursively, the Anthropocene is redefining humanity's relationship to the Earth, positioning humans not only as a dominant impact on climate and environment, but also as vulnerable to the agency of earth systems. Anthropocene discourses break down distinctions between humans and nature and legitimate efforts at planetary management, but also arguably obscure human inequality and diversity (Crutzen and Schwägerl 2011, Baskin 2015, Moore 2016). Climatically, the Anthropocene can be characterized as an epoch of instability triggered by human activity, in contrast to the stable hospitable climate that accompanied the development of civilization (Steffen et al 2011). Dramatic changes such as the loss of major ice-sheets now seem inevitable, and reversing such impacts would require a much more extreme reversal in climate conditions and temperatures (Lenton et al 2008).

It is in this context that the climate system becomes the Humpty Dumpty of my title, perhaps already broken, certainly vulnerable to further drastic change, maybe even teetering on the edge of a devastating fall, and apparently impossible to restore perfectly. In the Anthropocene, arguably, with the power to break earth systems comes the responsibility to care for – and even repair – them. Attempting to repair the climate system through geoengineering is one possible response. Yet Anthropocene discourses also tend to frame humanity as a single entity, and potentially deflect attention from questions of justice and radical politics. From such a perspective, climate

[11] This version from Opie and Opie (1951).

geoengineering arguably promises to sustain industrial capitalism in the face of otherwise disruptive climate change.

This paper seeks to understand what climate repair might mean in the Anthropocene. It first reviews ways in which proponents and critics of climate geoengineering have engaged with ideas of repair, suggesting that these are typically simplistic and that more sophisticated approaches are desirable. It then proceeds by examining five different disciplines covering the broad territory of repair, where experience with, and debate regarding, repair is rich and long-standing. The aim is to surface and learn from ongoing debates rooted in embodied practice, not to essentialize the virtues revealed or to claim that they are necessarily transferable. The disciplines chosen are not necessarily direct analogues for climate geoengineering, but offer insights into ways in which repair is conceived and how such conceptions are changing in the Anthropocene. The paper then briefly applies these insights to climate geoengineering, seeking to stimulate more reflexivity in debate and practice. It concludes by outlining a initial proposal for the virtues of repair in the Anthropocene, based on the interlinked principles of care, integrity and legibility which emerge from analysis of the five arenas.

Climate geoengineering as repair

Climate geoengineering is typically understood as large scale, intentional, technological intervention in the processes driving climate change (Royal Society 2009; NAS 2015a&b). With its connotations of control over the entire climate system, climate geoengineering is arguably the signature Anthropocene technology. It includes both techniques to reduce net heating directly (solar radiation management or SRM) and to reduce greenhouse gas concentrations in the atmosphere (carbon dioxide removal or CDR). CDR approaches are slow-acting, and their practice at planetary scale threatens to disrupt other aspects of the earth system and human society particularly through demands for biomass (McLaren 2012). SRM approaches are typically considered to be relatively low cost, and high leverage, if also of higher risk than CDR. Moreover SRM would actually generate novel climates – especially in terms of precipitation regimes - even if global average temperatures were returned to preindustrial levels (McLaren, forthcoming). Even in the absence of climate tipping points, climate repair through geoengineering would therefore be at best partial and incomplete.

Despite such limitations, metaphors of the planet as patient or as machine in need of fixing dominated climate geoengineering discourses for many years (Nerlich and Jaspal, 2012; Loukkanen *et al* 2013). And as interest grew, some advocates sought deliberately to shift the discourse. One leading SRM scientist has argued that *"Geo-engineering is an absolutely terrible word … [with] connotations of Dr. Strangelove … in fact, it should be called something like climate restoration"* (Latham, cited in Kanchwala, 2012), while the chair of the Arctic Methane Emergency Group (the only scientists already calling for deployment of SRM) has said: *"Politically, I think "restoration" has the better connotations and sounds more valuable"* (Nissen, 2008). Others have suggested "*analogs in 'forest restoration', 'art restoration', and 'building restoration'*" and advocated treating 'climate restoration' similarly as a form of *"return of something to a former state through (intentional) action"* (Alano, 2008). In a similar spirit, the Bipartisan Policy Center

(2011) sought to redefine geoengineering as 'climate remediation' (despite some of their high profile taskforce members actively dissociating themselves from this particular suggestion).

Such ideas remain pervasive in geoengineering discourses. Biological CDR techniques such as afforestation and regenerative grazing and biochar, and even controversial ocean fertilization are discussed in terms of soil, land, habitat or species restoration (Lal, 2004; Nelleman et al, 2009; McLaren, 2012; Tollefson, 2013; Thomas and Gale, 2015). And much contemporary SRM modelling work remains focused on designing potential interventions which best 'restore' pre-industrial climates and minimize infidelity to historic climate states (McLaren forthcoming).

While technical and managerial metaphors such as those of restoration or remediation are widely used to support climate geoengineering (McLaren, 2016a), the idea that the earth could be 'fixed' as if it were an artefact that could be reconstructed is also often challenged. 'Fixing' is also often used pejoratively, evoking concern over the idea of a 'technical fix' (Fleming 2010; Markusson et al 2017). Fleming argues in 'Fixing the Sky' (2010) that the history of often fraudulent claims for weather modification offers clear warning against the misuse and hubris implied in such terminology. And reflecting a wider concern, activist Naomi Klein argues, "*the solution to global warming is not to fix the world, it is to fix ourselves*" (2014: 279).

Although such discursive battles did not change the terminology used in climate geoengineering discourse, the underlying beliefs amongst advocates for redefining the concept as remediation or restoration do not appear to have changed. In this paper I advance the view that a more considered analysis of the implications of ideas of repair could be helpful in promoting a more discriminating and politically aware assessment of both the broad concept of climate geoengineering, and of its various possible forms, in the context of the discursive Anthropocene.

Concepts such as restoration, remediation and repair imply certain connotations and presumptions. In particular these terms – in English at least - tend to suggest visual, functional, and historical fidelity – a suggestion that a good repair will lead to the repaired object looking, and performing in the way it did before the damage occurred. A repaired window will let in light and keep out the weather, for instance. A healed broken leg will look like it did before, and permit its owner to walk, run and jump as they did before. Discourses of climate restoration or remediation then evoke these mental models, implying an ability to restore the functionality and appearance of some prior climate state (despite the inherent limitations of climate geoengineering in this respect). Yet ethically, to focus only on function would appear simplistic and utilitarian at best, incomplete and misleading at worst.

In contrast, here I treat repair as inherently a political and moral intervention in the world, with multiple dimensions (Graham and Thrift, 2007; Verbeek, 2011; Cotton, 2014; Jackson, 2014). Repair is an integral part of the co-production processes by which humans engage with both the past, and the future (Groves, 2014). By implication particular repairs are morally evaluable as better or worse, permissible or impermissible. Yet mainstream ethical theories typically struggle to offer clear guidance for the uncertain futures of the Anthropocene (Groves, 2014). Rather than starting from a particular (universal) ethical stance, I recognize ethics as a contested and negotiated

space, structured by biological and cultural evolution (Fitzpatrick, 2014; Held 2006). In my efforts to identify and codify common 'ethics of repair' in a pluralist ethical framework, I therefore adopt a pragmatic approach, iterating between a descriptive elicitation of ethics from behaviours and practices (Minteer and Manning, 1999), and an evaluative assessment (rooted in Sayer's critical realism (2008)), which locates ethics in human values. In a practical sense therefore, repair has 'pragmatic ethics' or virtues – morally desirable values and characteristics, rooted in collective social and cultural understanding.

The pragmatic, empirical approach does not imply a descent into cultural relativism leaving no possibility of assessing practices or positions against an ethical benchmark. The practical ethics emerging in climate engineering can still be compared with and assessed against those from other disciplines or cultures. In this paper I seek to identify robust contemporary virtues of repair by examining practices in older disciplines where the ethics are – arguably – more mature. I am particularly concerned to identify commonalities in how the objects (or subjects) of repair are conceived, what agency those subjects are understood to exercise, and what forms of fidelity to past states are considered appropriate. I also highlight current debates over ideas of repair which appear relevant to, or stimulated by, the onset of the Anthropocene, in particular those relating to the potential for the repairer to exercise control over the subject of repair.

Such considerations open important questions for debate. What might framing climate geoengineering as repair reveal about the nature of the practice, who might undertake it, and why? If it is a form of repair, what is the subject of repair, and what forms of fidelity to the original might matter? For example would a 'good' climate restoration exhibit fidelity of appearance, function or process, or fidelity to a particular historic state? Would a focus on repair detract from or reinforce efforts to achieve climate justice? Could such a process of repair be politically transformative, or merely sustaining? In this paper I explore such questions, with a focus on the issue of which virtues should guide efforts at repair or restoration.

Diverse conceptions of repair

To identify salient values I review here a range of disciplines of repair with long histories, and active debate amongst practitioners and experts as to the relevant ethics of the discipline. Climate geoengineering researchers have already drawn analogies with restoration, remediation and other forms of repair. Here, extending and modifying a categorization based on Sennett (2013) I briefly examine reconstruction (of historic heritage); remediation (of human bodies); restoration (of ecosystems); and also reconciliation (of relationships) and reconfiguration (of cultural artifacts). In each case the treatment is necessarily simplified, and cultural variations in ethics left unexplored, in the interests of tracing out the significance of three virtues emergent in the current discourses of these disciplines: care, integrity and legibility, and highlighting relevant implications.

Heritage reconstruction

This section draws on expert and practitioner experience with material artifacts, particularly buildings, of historic interest and value. In many countries, and internationally, valued historic heritage is protected, and appropriate rules, standards and ethical practices for interventions, including repair and reconstruction, are debated amongst professionals and interested publics. Heritage reconstruction is of relevance to the Anthropocene climate challenge because, *inter alia*, like the climate case it seems to reflect people's desires to recover a past state of greater functional value to humanity, in the face of deterioration which seems to require active intervention. In heritage conservation the need for repair is more often a response to natural decay of artifacts whose functions have become redundant, than to direct or indirect anthropogenic harms, yet both are the result of similar economic and cultural transformations.

At first glance, the reconstruction of historic heritage might seem to exhibit the goal of fidelity or authenticity to some pre-existing state. However, even within the dominant ethic of 'preservation', simplistic ideas of visual fidelity have long been rejected, in favour of non-intrusive maintenance and reversible and 'legible' or 'transparent' repair – in normal circumstances (Burman, 1995). Large scale reconstruction (in line with historic records) is understood to be only clearly justified in cases of deliberate damage or war – such as the new 'old bridge' at Mostar in Bosnia, or the historic core of Warsaw, reconstructed after World War 2. Large scale reconstruction for aesthetic and economic reasons, for example at Carcassonne in France, is typically criticized as inauthentic and intrusive (Cameron, 2008). The Mostar and Warsaw reconstructions have both been recently listed as World Heritage Sites, though more for their cultural importance in providing memorials of those conflicts (a sort of 'narrative fidelity' of place), than for their material or historic fidelity (Cameron, 2008). In such cases the 'legibility' of the repair remains important, albeit resting more in the documentation than the physical form. At the opposite extreme DeSilvey (2017) discusses cases of 'curated decay' in which natural deterioration is documented rather than halted, as a means of providing a similar memorial function in different ways, while recognizing the agency of the linked material and natural systems as 'ecofacts' rather than artifacts.

For more contemporary artifacts, one might assume that functionality is all that matters, but in repair and mending scholars such as Jackson (2014) and Middleton (2014) reveal emerging pragmatic ethics in which repair reflects attachment (and values of sustainability as opposed to consumerism) rather than simple need and functionality – repaired clothes are returning to fashion, repair cafes are spreading around the world. Mending is becoming visible, rather than invisible. The process of repairing is perhaps even being recognized as a character building virtue, rather than an activity to be hidden away, and left to (or imposed on) marginalized groups in society.

Even though the analogy between designed artifacts and the climate is far from perfect, there are interesting lessons already here. The justification for reconstructive approaches in cases of deliberate damage – such as in wartime – might imply a similar justification for climate repair through geoengineering, but this justification would appear weak if the reason for geoengineering were instead to maintain economic interests which might be threatened by the alternative of accelerated mitigation. More generally, even though current people may be able to identify the intentions and

purposes of the original builders and designers, ethical repair of historical artifacts involves something more (and in some respects, deliberately less) than functionally, materially and visually faithful reconstruction. In part that reflects an ethical respect for the artifact itself and its history and narrative and an understanding that the morality of things is in important ways co-produced between designers, users and the things themselves (Verbeek, 2011; Sennett, 2013; Cotton, 2014). Yet the agency of artifacts is still limited, and often unrecognized.

Next I consider a sphere in which the agency of the subjects concerned is generally clear and accepted: repair of human bodies.

Medical remediation

The focus of remediation is on restoring function through healing and medicine. In mainstream medicine the key ethics are to 'first do no harm, to act in the best interests of the patient, to respect their autonomy and to allocate treatment resources fairly' (Beauchamp and Childress, 2008). With human subjects, as opposed to inanimate artifacts, the ethical goal is clearly to recover integrity, autonomy and agency. Medical ethics recommend interventions that (as far as possible) support the subjects' bodies to heal themselves.

Human bodies may seem a poor analogue for the Anthropocene climate, and there are substantial practical differences. But medicine offers profound insights into how we respond when agency in the subject is recognized (and the Anthropocene arguably demands that we recognize the agency of earth systems as much as the human agency to change them (Clark 2011)). A central debate in medicine addresses the extent to which contemporary practice dehumanizes patients, treating them as objects. As a result, medicine is one of the arenas in which a feminist ethic of care has emerged to promote a focus on the individual as a relational human agent, their needs and vulnerabilities, on the solidarity and attachment between carers and patients (helping patients become agents), and to challenge the medicalization of health systems and their relative domination by interventionist medicine (Gilligan, 1982; Tronto, 1994; Held, 2006). The ethics of care seek to treat the subject as an active participant in the healing process, as well as an individual whose consent is demanded.

In remediation, the dominant ethic with respect to appearance is one of invisible mending. We don't want surgeons to leave us with unsightly scars any more than we want impaired function. Nonetheless, there are debates about the role and appropriateness of legibility as opposed to invisibility, especially where natural healing is impossible, and surgical reconstruction is an option. Ideas of legibility appear in diverse forms – typically secondary to function – such as tattoos over surgery sites, or artistic prosthetics (Eveleth, 2015a,b). This can be seen as a demand for a form of recognition of identity (Fraser and Honneth, 2003), similar in some ways to demands for recognition from subaltern groups expressed through movements such as gay pride. In both cases legibility enables open expression of participants' identities and narratives (Galinsky et al, 2003) – and again indicates the significance of narrative fidelity.

New technology also raises issues in medical ethics: notably the prospect of enhancement (as opposed to remediation), a development with direct parallels for climate geoengineering, with its apparent potential for 'designer climates' in the Anthropocene. Human enhancement exposes deep uneasiness amongst both publics and medical practitioners, with profound contestation over the use of drugs, medical implants and gene therapies which step over a boundary from repair to enhancement. For instance, use of memory enhancing drugs to combat senility is seen as right and proper, but not to help healthy teenagers cram for exams (Reiner, 2010). Human enhancement is another front line of the Anthropocene: Promethean versions of the discourse welcome such opportunities, while more skeptical approaches fear the hubris and inequality implied by such technological change (Juengst and Moseley, 2016).

Again the analogy is imperfect, but medical remediation highlights the importance of agency and autonomy for the subject, the risks of dominating paternalism, the significance of narrative fidelity and the differences between repair and enhancement. While the climate system itself cannot be consulted about geoengineering interventions, other stakeholders might be, and the design of any intervention could helpfully take account of the risks of human hubris and domination, beginning by recognizing that any use of SRM would likely need to be continued until underlying greenhouse gas concentrations had been reduced by other means. Next I examine a perhaps closer parallel in which the subject – while living and clearly enjoying substantial agency – cannot be directly consulted: ecosystem restoration.

Ecosystem restoration

Ecological conservation and management has a long history, but in recent years ideas of ecosystem reconstruction and rewilding have become much more widely discussed and attempted, in part as a response to the additional impacts of climate change (Higgs, 2012; Sandler, 2012; Light, 2012; Monbiot, 2013).

On the surface ecosystem restoration offers a strong analogy for climate repair. The subject is a system, with some independent agency, restoration is needed because it has been damaged as a side-effect of economic and social activities that serve human needs and aspirations, and the repaired system itself may also serve some broader function for humanity. Yet, once again, functional restoration is only a part of the ethical practice of ecosystem management in the face of breakage or damage.

Ethical debate in this discipline often focuses on the implications of the impracticality or arbitrariness of choosing any particular baseline state to which to restore; and on the associated risks of humanity dominating by determining the nature and purposes of the restored ecosystems and their species. Some scholars and practitioners see in this a denaturing of the ecosystems concerned, either in terms of the loss of something integral to their nature; or their conversion to an artifact; or both (Katz 2002, Hettinger, 2012). Higgs (2003, 2012) argues a case for simultaneously supporting ecosystem integrity, historical fidelity to place, and intentional human participation (recognizing humans as part of ecosystems, but resisting the hubris of domination). Others, such as Marris (2011) see no practical or ethical problem in such artifactualization.

More generally, ecologists and ethicists appear to concur that humanity has obligations to repair damaged ecosystems (Light, 2012; Basl, 2010; Lee et al, 2014). But repair also risks a form of moral hazard, insofar as promises of restoration can be used to justify destruction of ecosystems for economic purposes (based on unenforceable promises of subsequent restoration). In this situation repair potentially becomes utilitarian; which threatens to devalue impacts felt by unrecognised groups such as indigenous people, future people or non-human species; and generates limited pressure to rectify historic wrongs, or to prevent future risks. In the climate context, it would seem vulnerable to the same problems of moral corruption that have slowed mitigation (Gardiner, 2006), while also risking enabling arguments to be made for SRM on the grounds of reduced cost (once an economic metric is accepted).

But repair can alternatively be justified as a process that reverses harms done, or respects ecosystem rights. This permits a clearer focus on the integrity and agency of the system. As with remediation, the restoration of self-directed functioning and active (ecosystem) processes appears most important here, rather than return to a particular baseline or appearance. For instance, the return of wolves in rewilding efforts is more significant for the ecological role the predator plays, than for the specific species itself. And as with healing, legibility appears as a secondary but potentially valuable ethic, not just as an active reminder of our power, but also as a faithful part of the narrative (of place in this case (Higgs, 2003; 2012)) that underpins our identities. In the absence of a clear historic baseline, other ethics come to the fore, in place of historic or visual fidelity, including greater respect for the cultural values and narratives associated with the subject (perhaps, as with heritage above, as forms of memorial, rather than preservation). In some ways the subject of repair is also a relational cultural or socio-ecological system extending beyond the physical boundaries of the habitat concerned. Next in this rapid survey, I turn to a form of repair where cultural values are central: artistic reconfiguration.

Artistic reconfiguration

Reconfiguration is categorised as a particular form of repair by Sennett (2013), one that not only recovers but enhances function with a mix of existing and new elements. The relevance to climate repair might seem limited, but the climate is of profound cultural importance, and indeed can be understood as fundamentally a cultural, rather than natural artifact (Hulme 2017), even before the Anthropocene. In this respect the subject of 'repair' is a linked cultural-physical-environmental system – involving both the physical objects concerned, but also the relationships and attachments between them and humans. And while artistic understandings of reconfiguration move even further from fidelity to some pre-existing state, this does not mean that 'anything goes'. Artistic work is still guided by socially determined ethics, which, amongst other things, value art for its intrinsic expression of humanity, rather than for its commercial worth.

Historic reconstruction can blur into artistic reconfiguration. In the Japanese art of Kintsugi, for example, damaged pottery is repaired with a gold coloured cement – arguably enhancing the beauty of the artifact by marking the lines of repair and highlighting the history of the object in a sort of 'narrative fidelity'. Understanding the

cultural value of the subject is central to this form of repair. Similarly, the war-damaged Neues museum in Berlin was reconstructed with a mix of historic and contemporary materials, making the story of the damage and repair highly visible (Sennett 2013). The result directly illustrates the conservation ethics that inform the management of the museum's collection of antiquities, as well as its structure. Reconfiguration thus bridges repair and making, and blends the roles of artisan and artist (Galarraga and Szerszynski, 2012).

In this context – and remembering that SRM would create novel climates, rather than simply restoring previous states – artistic reconfiguration in domains where repair is a minor aspect of the artist's goal may also offer useful lessons. In literature and music, there are long standing traditions of borrowing and reconfiguration, which can be understood as the recovery or rehabilitation of disused cultural material. And insofar as we understand art as a process less of de-novo invention, and more a tradition of cultural borrowing, improvisation, mashing-up and reconfiguration of ancient elements in new forms, then much repair can be seen as artistic. Throop (2012) for example sees improvisation with dramatic and musical analogies as a virtue in ecological restoration.

Such an understanding of art as reconfiguration is not uncontested. Current battles over copyright suggest that a form of fidelity to and preservation of existing artistic creation is valued, but viewed historically, it is the brief era of strict copyright that is the artistic anomaly (Brewin 2012). Author Neil Gaiman explains a similar shift in attitudes to stories, with particular reference to fairy-tales, repeatedly retold and reconfigured over centuries (Gaiman, 2007). Like ecosystems and the climate, such cultural goods are fundamentally common goods (Brewin, 2012). This is not to suggest ignoring the harms that arise where cultural resources are appropriated from subaltern groups without acknowledgement or recompense – for example where white musicians systematically 'borrow' from black musical traditions. Justice as recognition would suggest that artistic borrowing of cultural resources must instead be part of a process that both respects cultural difference and seeks to increase intercultural understanding (Nicholas and Wylie, 2012). By implication the borrowing or expropriation of climatic resources through domination by climate geoengineering would breach such ethical principles.

The idea of respect for sources is perhaps the central ethic of such artistic reconfiguration. In discussing the Neues museum, Sennett (2013) writes tellingly of a metaphorical dialogue between the restorers, the original builders and the building itself. Reconfiguration emphasizes the cultural dimensions of repair, but at the same time, blurs not just ideas of historic fidelity, but also those of functional fidelity and even integrity, making narrative fidelity and legibility even more critical. For geoengineering, as a process that would reconfigure the climate (as will be seen in the discussion section), these lessons may prove critical.

Relationship reconciliation

Finally I consider an even less tangible and more cultural form of repair – reconciliation deployed to repair broken relationships, particularly in the aftermath of violence or crime. The relevance of this should be clear in the light of the understandings above of both ecosystem restoration and artistic reconfiguration as extending to the relations

between the material objects and humans who have meaningful, identity-forming attachments to those objects. From this perspective, lessons from repair of relationships can also be applied to climate repair.

Reconciliation is a restorative form of corrective justice, which seeks to reinstate the offender as a functioning member of the community through acknowledgement and forgiveness of their crimes (and treats the perpetrator, the victim and the community as valid stakeholders in the process of repair). Such approaches have been widely used, but none so large-scale and high-profile as South Africa's post-apartheid Truth and Reconciliation Commission (Gade 2013). In different ways an ethic of legibility and narrative fidelity appears again: central to such processes is a desire to ensure no pretense that the damage was not done. Forgiveness may be accompanied by forgetting, but as with DeSilvey's (2017) challenge to preservation of heritage, the process is managed or curated with care, to deliver an appropriate memorial function.

In this arena there is also a clear principle of humility and restraint: a recognition that we are but human and fallible, and it also reflects a strong ethic of care in the sense of rebuilding the internal ties of community – as the South African concept of Ubuntu suggests: people are not isolated individuals but achieve humanity only through their relations with other people in society (Gade, 2013). In this context, Ubuntu is an ethic of repair focused on the fabric of community and society. It calls for humility and restraint, and a hesitancy to judge and condemn. It suggests building character and demonstrating solidarity, rather than domination.

Ideas of reconciliation and restorative justice are not limited to the global South. Restorative forms of justice are spreading in many countries with novel forms of inter-cultural awareness building, dispute settlement, post-conflict reconciliation, as well as approaches to even criminal offences that focus on generating forgiveness and reconciliation between perpetrators and victims. Considered globally, reconciliation in a climate context might extend to post-colonial relationships, and solidarity and between north and south, rich and poor, human and nature. As Hourdequin (2012) suggests, climate policy that builds solidarity (rooted in accelerated mitigation and climate justice) is more likely to win the necessary global support than climate geoengineering which can be seen rather as domination.

Reconciliation emphasizes the significance of cultural and local identities – which can be (in part) embedded in particular climate states, and again the significance of care for the subject, and for narrative fidelity in the process of repair. Reconciliation raises particular questions regarding the nature of the subject of repair, which could be highly pertinent for climate repair.

Discussion: climate geoengineering as repair

There are many questions raised for climate geoengineering by the foregoing consideration of different approaches to repair. Here I wish to focus briefly on two topics that are central to the application of lessons from the five forms considered above: what *form or forms* of repair climate geoengineering might constitute, and what the *goals and subjects* of such a repair might be. I then identify and discuss three

common virtues that emerge from the above, and conclude the section by considering and seeking to rebut some potential challenges to applying a repair approach to the topic of climate geoengineering.

What sort of repair would climate geoengineering constitute? Narrowly defined it would appear to be primarily reconfiguration. Eli Kintish's term 'hacking the planet' (2010) seems more apposite than 'fixing the sky'. But does this mean that prospective climate geoengineers should apply only the ethics of the artist, and not those of the artisan, healer, restorer or peace-maker? In practice, the climate appears to be more than just a cultural object. In that case, if climate engineering could only be deployed as reconfiguration, does this mean that it should not be deployed at all? Mitigation would appear to far more closely achieve the goals and respect the virtues found in remediation and reconciliation as described above, notably the principle of 'first do no harm'. Moreover, insofar as it would seem to require human behaviour change and character reform rather than purely technical and economic measures, mitigation is potentially a restitutive form of restoration (Basl, 2010). Yet mitigation may no longer be rapid enough to avoid dangerous climate change. It appears that what humanity might value about climate geoengineering is the extent to which it might deliver aspects of restoration, remediation and reconciliation (over human timescales of decades rather than centuries). In this case it is important to consider what ethics or virtues might properly apply to such a prospect.

Framing climate geoengineering as a repair tool might initially appear to imply not only a process of restoring form and function, but also that it is *the climate* that is broken. However, the diverse forms of repair considered above highlight the prospect that the appropriate subject of repair might be different: the earth system, ecosystems, society, even relationships. Even if focusing on the climate specifically, what would be the goal? What does a 'return to healthy functioning' constitute? As far as the climate itself is concerned the current state might be reasonably understood as 'healthy functioning' for a high carbon world. This has two implications: first, to acknowledge that any meaningful goal may have to be anthropocentric to some degree: a system that also supports human healthy functioning. But second, that the subject of repair must therefore also include the human part of the climate system. Openness about our anthropocentrism must incorporate a willingness to see ourselves as a part of the problem, and a potential subject of repair. But this also needs to be coupled to an understanding that there is not at present a single anthropos, that humanity remains divided, and those mainly responsible for the environmental impacts underlying the Anthropocene are a particular minority of humanity (Baskin, 2015; Moore, 2016).

In the examples discussed above, it is clear that the question of what goal or state to aim for (often considered in terms of historical fidelity) is endemic. It should also be clear that in the face of uncertainty or even indeterminacy over what is appropriate, and equal uncertainty over whether goals can be predictably achieved, there are better ways to describe the goals of climate repair. They include recognizing the subject of repair as a subject of care and seeking to enhance its functional and procedural integrity, while providing for some form of narrative fidelity or legibility.

In other words, I suggest that three key principles emerge (see table 1):

- Expressing a virtue or ethic of care: which embodies humility about our capacities, and focuses on the subject's specific needs, reflecting our respect for and attachment to it as an agent in itself, rather than an instrumental use purely to meet our needs.
- Seeking an outcome of integrity – in which the subject has recovered self-directed functioning and healthy process, as far as possible, avoiding a process of denaturing or artifactualization by repair.
- Applying practices and procedures that are visible and legible, and do not attempt to misleadingly cover up the repair or the damage done, but expose culpability and complicity and encourage reconciliation.

Table 1: Emergent ethics of repair in five domains

	Care	Integrity	Legibility
Reconstruction	Maintenance preferred to reconstruction. Individuality of object and context important.	Interventions should be reversible, protecting the historic integrity of the object.	Ethical interventions are transparent and documented, permitting reversibility.
Remediation	A relationship of care for the individual subject is central, with emphasis on consent and even active participation.	Restoring autonomy and self-directed functioning. Unease with enhancement rather than remediation.	An emerging (if minority) cultural view supports visibility of prosthetics and reconstructive surgery to demand recognition.
Restoration	Restorers demonstrate clear attachment to the systems they work to restore.	Restoration of self-directed functioning – focused on re-establishing natural process	Honest narrative of place, preserving the 'disturbance memory' (Light)
Reconfiguration	The artist recovers or rehabilitates cultural material, which is a subject of their care	Integrity is more about the artistic process, than about authenticity to the source.	Respect for and acknowledgement of cultural sources, creating narrative fidelity
Reconciliation	Care for the relationships between individuals or within functioning communities is central to reconciliation	Aims to restore or re-establish the integrity of the damaged community or relationship	Demands honesty about the harms that were done: no pretense or covering up. Narrative fidelity is clear.

These virtues of care, integrity and legibility arise in diverse ways in all the disciplines of repair considered above, and together, I suggest, constitute an appropriate 'ethics of repair' for the Anthropocene. This is not to suggest there is a uniform convergence of

virtues and principles across all five arenas, nor intended to give an impression of consensus even within the disciplines considered: the ethics of repair are in many respects contested and often culturally specific – for instance with respect to the relative importance of fidelity of material, form, process, history and narrative. However in each of these three areas there is more commonality than contestation.

The following three sub-sections unpack these principles further and discuss how they might apply to climate engineering.

An ethic of care

An *ethic of care* is expressed in forms of repair and maintenance which are primarily rooted in attachment to the subject, rather than in functional concerns or even obligations of justice. In some ways this echoes – and extends - the Kantian dictum never to use people as means, but always to treat them as ends in themselves. As an ethic, care (Held, 2006; Tronto 1994) respects agency, and can be counterposed to ideas of medicalized treatment, or decisions made on anthropocentric judgments of value. It shows *respect* for the subject, its dignity and origins, expressed where practical in consent and involvement. Care in repair is closely associated with virtues of *humility* and restraint, which recognise the limitations of human interventions. Care is particularly strongly expressed in ideas of repair as reconciliation, and this too can be usefully applied to the climate, where arguably the thing most in need of restoration or reconfiguration is not the climate itself, but humanity's exploitative, instrumental relationship with the Earth.

Similar contrasts between an ethic of care; and more technocratic approaches of reconstruction or reconfiguration - rebuilding ancient monuments; enhancing human capabilities with drugs or surgery; or cultivating 'rambunctious gardens' (Marris, 2011) – are found in the context of buildings, health, and ecosystems. This is not a simple dualism, however, but a spectrum. An ethic of care might prioritize the ongoing maintenance of sustainable low-carbon lifestyles, while the technocratic approach is more open to attempted large-scale reconstructive interventions. Yet even grand climate geoengineering interventions might learn something from the ethics of care emergent in other fields or repair: not just about whether to intervene, but when and in what forms, and with what governance. For example, proposals to use SRM to retard rates of climate change (Keith 2013) might express care better than those suggested to reverse all warming.

While care recognises individual needs and vulnerabilities it is not purely individual. It is rather inter-subjective and relational. As care, repair can be seen fundamentally as a means of building solidarity within and between societies, and with their supporting environments. In the context of the climate, this implies seeking interventions that work to deliver corrective and restorative forms of climate justice, and moreover, ones that help tackle economic and social inequalities and injustices too. It is hard but not impossible to consider ways in which climate geoengineering interventions could help do this (Buck 2012b, Martindale 2015) – particularly in CDR forms, but all too easy to see approaches – especially to SRM - that reflect a paternalist and technocratic hubris, in which geoengineering 'solutions' sustain existing injustice (McLaren, 2016b).

Care implies humility rather than hubris. Sandler is not alone in dismissing the idea that humanity has the necessary capacity to predict and control, and criticizing climate geoengineering as "*again trying to adapt the world to humans, rather than vice versa*" (2012: 77). Most climate geoengineering proposals are rooted in social imaginaries of risk management (Groves, 2014) in which technical expertise can be deployed to control risks, rather than focusing on vulnerabilities and means of building capabilities and resilience (McLaren, forthcoming). Such hubris exacerbates the moral hazard of 'restoration' – the idea that the availability of repair mechanisms permits humanity to delay maintenance and mitigation. Our susceptibility to such temptation (Gardiner, 2006) could itself be seen as a behavioral flaw meriting repair. Devising climate geoengineering interventions that effectively exhibit an ethic of care will be challenging in this context.

Integrity

Rather than recovery of a baseline state, many forms of repair seek to achieve a form of authenticity that might best be described as *integrity.* This is a coherence with the intrinsic functionings and processes, and essential virtues of the subject (as a relational system). It is implied in the respect for sources seen in reconfiguration, and clear in the autonomy and agency sought in medical remediation and ecological restoration. The pursuit of integrity means repair that helps the subject recover self-directed functioning and healthy processes. On the other hand repair processes which dominate the subject, impose external visions of reconstruction or enhancement, or act to denature it by converting it from a natural system to an artifact are all seen as ethically deficient in their relevant fields.

The key challenge of integrity for climate geoengineering is whether it removes agency from the climate system, turning it into an artifact. Sandler (2012) argues that simply because restoration requires design, restoration reduces ecosystem agency: design is inescapably anthropocentric in this view. Galarraga and Szersyznski (2012) similarly suggest that with SRM "For the first time we would have a made climate" (p221). Intentionality appears central to such an understanding of 'made-ness' (in contrast to climates made unintentionally by the effects of widespread agriculture and forestry (Ruddiman et al 2014), or in cultural ways (Hulme 2017)). However made-ness would seem equally to incorporate some notion of effectiveness, which is far from certain in climate geoengineering (Stilgoe, 2015). If humanity could not in any sense obtain outcomes that reflected its designs or intentions, then the production of the new climate would be less 'making' and more a process of accident, or 'emergence'.

Given the cultural significance of climate, it would remain ethically problematic even if the denaturing of the climate were only discursive, rather than physical. Nerlich and Jaspal (2012) highlight how the linguistic emphasis on 'fixing' the climate drives a metaphorical transformation of the climate into an object that needs repair, using a technological toolbox (or a body needing treatment with a medical toolkit). Such discursive framing underpins Anthropocene discourses such as that of the 'Rambunctious Garden' (Marris, 2011) which treat such interventions as normal and appropriate, implying, for example that human choices would (and perhaps should)

structure the species mix and management techniques applied to ecological systems (as they do in gardens). Keith similarly highlights past change in ecosystems as validating continued intervention, "in part, their value lies in the history of how they got the way they are, the co-evolution of nature, culture, and technology" *(2013 p.xviii).*

Even if the climate system could be structured through such intervention, and however inevitable it might appear, such thinking justifies anthropocentric domination and *de facto* denaturing. The integrity principle is clearly being ignored in such circumstances. On the other hand, once the climate is recognized as more than an artifact, the integrity principle helps one to conceive it meaningfully as a relational system with agency, or at least an autonomous status, which merits human care.

Legibility and narrative fidelity

The third and last common principle is that of *legibility.* This demands repair practices that are transparent and leave a visual trace that – at least to an expert eye – effectively inscribe the repair into the narrative or history of the subject. This clearly appears in reconstruction, remediation and in ecological restoration. It is also inherent in reconciliation, where the mending process typically demands open acknowledgement of the damage by the perpetrator and the requesting and granting of forgiveness for it from the victim; and in the demands for respect for sources in reconfiguration. In some cases legibility also supports or enables reversibility of the process (as in heritage reconstruction).

In the foregoing I have associated legibility with the idea of narrative fidelity on the basis that – in contrast to efforts at invisible mending - an honest and faithful narrative or history of the subject must include a record of its damage and repair. Narratives not only support the continuity of places but also underpin human identities. This one of the reasons place-based restoration of heritage and ecosystems is so intensely scrutinized and its qualities contested. The reconstruction of Mostar and Warsaw (and their listing as World Heritage) was arguably driven by a "*deep-seated desire to resurrect identity"* albeit in the exceptional circumstances of "*deliberate destruction of cultural resources through war*" (Cameron, 2008: 23). Questions of culture and values would be challenged by 'climate restoration' in the same ways as by the reconstruction of the Mostar bridge, or the reintroduction of the wolf in rewilding efforts. Repair is never simply about technical questions of function and material performance.

In many cases – and the climate would be one - the ethical case for legibility is not just rooted in the honest record of the object's history, but in the memorial it creates regarding the cause of the damage. In this respect the transparent reconfiguration of the Neues is arguably more valuable than the reconstructions at Warsaw and Mostar, where the memory resides in the listing and its documentation, rather than the physical form. There is an intriguing parallel here for SRM climate engineering. The most widely discussed form: stratospheric aerosol injection (SAI) would leave two visible traces – it would whiten skies, and redden sunsets. In the conception of ethical reconfiguration I have set out here, these visible marks should be valued as a reminder not only of the damage humans have done to the climate, but of the ongoing negative side effects of SAI which include slowing ozone recovery. They would potentially provide a constant

stimulus to enhance our efforts to accelerate mitigation and bring SAI to an end. Yet some geoengineering researchers are considering not only how to design particles with fewer side-effects, but ones with negligible light-scattering effects, which would eliminate the legibility of the repair (Keith, 2013).

Such efforts would turn climate repair into yet another element of the invisible maintenance and repair that constitutes a hidden shadow to neoliberal industrial capitalism. The modern world is arguably much more dependent on maintenance and repair than on innovation and invention, yet the latter are lauded, and the former concealed (Jackson, 2014). As an ethic for the Anthropocene, legibility of repair seems essential. In an era where repair is unavoidable as a result of the accumulated impacts of humanity on the earth and its systems, it is critical to bring repair out of the shadows: it cannot remain a discipline delegated to subordinates and minorities, nor can its aesthetic remain that of invisible mending. Both the processes and outcomes of repair should be visible and legible if it is to be practised ethically.

Some challenges to a repair approach

Before drawing conclusions I want to discuss two challenges that might be legitimately raised to applying ideas of climate repair to geoengineering. Firstly that it risks discursively and inappropriately framing the climate as an object amenable to human intervention and in so doing risks magnifying the moral hazard associated with climate geoengineering. And secondly that it frames appropriate interventions as politically conservative (rather than radical, or transformative), a criticism that fits within a wider critique of the Anthropocene discourse as distracting attention from political questions of injustice.

The first risk is real, but derives mainly from misunderstandings of repair in popular discourse. More systematic analysis, such as that set out in this paper, reveals that ideas of repair need not embody hubris regarding human control, but to the contrary, repair practices often reflect a concern for the agency and autonomy of the subject. But in the absence of such humility, the risk of moral hazard should be recognized. The more it appears that climate geoengineering could 'repair' a damaged climate, the easier it may be for businesses and politicians to justify continuing emissions. The lack of historic or functional fidelity of repair by SRM geoengineering (which would not reverse ocean acidification for example) means that moral hazard has to be taken seriously, even if substituting it for mitigation would be irrational (McLaren 2016b). However, our review above demonstrated that historic fidelity is a challenge in most forms of repair, that neither historic nor functional fidelity need be perfect for repair to be valued, and that other forms of fidelity should be considered also. So the moral hazard problem – while serious - does not invalidate considering ideas of repair.

It is also reasonable to note a broad association between repair and conservative political views. Again however, this is rooted in the common perception of repair as advocating a (politically conservative, or nostalgic) longing to return to some historically previous state, or as sustaining the status quo; rather than embodying a progressive or radical future-oriented stance. This problem is reinforced by framings of the Anthropocene that falsely or at least prematurely unify humanity into a single entity

(Moore, 2016). These frame out questions of justice, and radical political solutions. The analysis above suggests that treatments of repair in mainstream scientific discourses of climate geoengineering might indeed mobilize it as a conservative, sustaining technology, deployed to enable a gradual transition of eco-modernization, or even harnessed to a neo-liberal libertarian promethean agenda (McLaren, 2016a).

Once again a more sophisticated understanding of repair indicates ways in which ethical repair could challenge such framings. Once the subject of repair – broadly understood - is recognized as an active agent, and participant in the process of repair, the politics of repair is potentially upended. If the interests and perspectives of post-colonial or subaltern communities in the global South (the primary victims of climate injustice) become heard and counted in a reparative process of reconciliation, it even holds out the prospect of a moment of genuine politics (Rancière 2004). And if the interests and perspectives of the climate system or indeed of the technologies involved in repair activities can be voiced, then such a moment may even extend (contra to Rancière) beyond the human. Further, the focus of integrity and legibility on a respect for situated narratives of place and identity necessarily rejects the universalist and paternalist treatment implied in eco-modernization and promethean framings.

Radical approaches might particularly suggest exploring lessons from reconfiguration, but also the ways in which reconciliation and repair might heal divisions, including through genuine restorative justice, as long as such obligations of repair are understood not as a general universal duty on humanity, but primarily as a duty on those responsible for historic and ongoing division, harm, and breaches of rights.

Moreover, while care is often counterposed to justice in ethical terms, and repair might be similarly framed, the ethics suggested above would rather strengthen the prospects for climate justice, understood through a lens of justice as recognition (Fraser and Honneth, 2003; Schlosberg, 2007). Recognition theorists in moral philosophy argue that justice depends upon full and proper recognition of each individual and their identity, enabling fair treatment, appropriate redistribution and the development of essential capabilities (Fraser and Honneth, 2003). Environmental justice scholars highlight the importance of respecting community and movement based demands for recognition of identity, difference and interests (Schlosberg, 2007; Walker, 2012). Understood in these ways recognition underlies all three of the identified ethics (care, legibility, and integrity). Care for the specific subject is based in recognition of the subject and their agency, requiring the practitioner of repair to see the actual subject, not just its condition. Integrity relies upon the recognition of difference, and thus seeking to restore the essential nature of the subject, rather than paternalistically projecting the repairer's ideals. Legibility implies revealing the narrative of identity of the subject, which in turn is central to recognition (as in history of slavery for instance). These may stretch ideas of recognition beyond conventional applications in moral philosophy, but not beyond the ways in which recognition is applied, and demanded in movement based politics and environmental justice scholarship (Schlosberg, 2007).

Disaggregating and unpacking ideas of repair – and particularly the virtues expressed in real-world practices of repair – thus offers new ways to engage with and enrich our climate policy options in the face of the uncertain, and broken futures of the Anthropocene. Caring both for the climate, and the human communities that depend

upon it physically and culturally. Recognising the essential and inter-related natures of climate and earth-human systems, and seeking to restore their integrity. Approaching repair and reconfiguration with humility not hubris, carefully marking the traces of human interventions. And seeking restorative justice based in recognition and reconciliation.

Conclusions

I have argued that a sophisticated understanding of repair reveals valuable virtue ethics that could guide human interventions in earth systems in the Anthropocene. While understanding the Anthropocene implies accepting inevitable anthropocentricity in both how humans understand and impact on the world, it also implies retreating from the sort of anthropocentricity that puts human goals at the center of the Earth system. That would lead to 'denaturing' the climate in both senses of the term: changing its essence, and extracting its 'natural' aspects. This is not to suggest that the climate today is some independent wholly natural object, rather that it is a linked cultural-natural system, relationally incorporating humanity through our attachments to it (Hulme, 2017, Groves 2014). Moreover its essence includes some independent agency to the extent that it may be appropriately considered as a rights-bearer independent of its human components.

In engaging with such a subject of repair, I have argued that potential climate geoengineers need to learn from other disciplines, and apply virtues of care, integrity and legibility. This does not mean abandoning ideas of fidelity in repair, but – recognising the impracticality of entirely reconstructing the climate humpty, it focuses our aims on fidelity of function, process and narrative in reconfigurative forms of repair, not narrowly on form and history (which are notably often western cultural tendencies). With respect to climate policy, these virtues reinforce arguments that accelerated mitigation and adaptation are preferable responses, but they could also help guide the procedures, aims, practices and governance of climate geoengineering should it be considered an essential complementary climate measure. Future work could usefully probe further into the diversity of culturally specific conceptions of repair and restoration to help improve the methodologies of pragmatic ethics, strengthen the empirical foundations of the virtues described here, and to help design ethical and just responses to climate change.

It must, however, also be acknowledged that the climate Humpty's fall can no longer be seen as an accident: people know what greenhouse gases are doing to the climate, yet most refuse to cut emissions as quickly as they could. Intentionality would seem to convert obligations to repair through reconfiguration also into obligations of reconciliation, with the earth and its diverse peoples and species. Yet the idea of reconciliation carries a further meaning worth reflecting upon: not just rebuilding community, but also being reconciled to transience and change as part of the nature of the Earth – even, or perhaps especially in this age of humans.

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Chapter 4: Synthesis and Discussion

Following the five papers in Chapter 3, here I turn to a synthesis and deeper discussion of the justice issues they raise, also drawing on the theoretical considerations outlined in Chapter 2. This chapter begins with a brief contextual outline of climate politics as it pertains to justice and CGE (building on the introduction to this kappa), suggesting ways in which CGE is being incorporated into, and co-constructed with, the dominant social imaginary. In the following sections I explore how consideration of CGE could instead lead to a need for reconfigured conceptions of justice (as a part of the new ethical thinking provoked by climate change (Hulme, 2009)). I begin by unpacking the political nature of moral hazard / mitigation deterrence and its relationships to our understandings of power (including notions of unilateralism and accountability), and to the dominant social imaginary. I then turn to the ways in which technological depoliticization of climate policy contributes to moral hazard through the framing out of key aspects of justice, and the narrow construction of the conceptions that remain. I show how these conceptions are constructed within (and co-construct) a particular risk-based social imaginary. Finally I examine ways in which dominant considerations of risk and vulnerability reflect a systematic and structural misrecognition of disadvantaged groups. I conclude the chapter by highlighting the significance of restorative dimensions of justice in alternative care-based social imaginaries which better recognize disadvantaged groups and future people.

4.1 Climate politics, justice and geoengineering

Seen from the foundations set out in Chapter 2, climate change is not a problem with a technical solution, but a politically contested challenge to the presumptions of the dominant social imaginary. In those contests, struggles for justice, and especially recognition of remote and future victims of climate impacts, which underpin demands for social and behavioral change and global redistribution, can be seen in tension with technocratic efforts to maintain the (neo)liberal, capitalist social imaginary.

As Hulme (2009) argues, to understand climate politics is to see climate change as an environmental, cultural and political phenomenon. These contests underlie the long-running debates over climate justice at the UNFCCC, where a rhetorical commitment to 'common but differentiated responsibility' has still proved inadequate to bring agreement on practical emissions cuts of the scale required. Nationally, whether under the Kyoto protocol of weak top down targets, or the current post-Paris regime of nationally determined contributions,

there has been widespread failure to deploy plausible technical and technological approaches to mitigation (or at least to do so in frameworks that generate emissions reductions rather than rebounds). As *Paper 4* suggests, the measures taken to constrain emissions have largely been constructed within discourses of ecological modernization or green capitalism, rather than radical alternatives.

And so today, humanity as a whole (regardless of all its diversity) faces likely serious climate change. Global temperatures will rise further, possibly by several degrees, as a result of emissions already made, and those largely committed through economic investments in facilities, buildings and equipment. In other words there is both economic and climate inertia in the system. Yet there are still huge uncertainties, perhaps less in the estimates of physical climate sensitivity to forcing, than in the rate and scale of economic and cultural change. If we accept the desirability of 'avoiding dangerous climate change' (as the political rubric puts it), then we face serious uncertainties, a high level of ignorance and possibly inherent indeterminacy. On the basis of carbon budget estimates (e.g. Rockström et al 2016, Geden 2013, 2015) it seems likely that to avoid dangerous change, there will be a requirement for large amounts of CDR in the coming decades, and plausible that SRM may also be needed to control damaging rates of change. Almost all climate pathways modeling now involves substantial CDR, and those that do not tend to assume a peak in emissions at a date that has already passed (Fuss et al 2014, Anderson 2015). In other words, civilization needs either carbon geoengineering, or a time machine (Anderson 2015). Yet without accelerated mitigation (and a forgiving level of climate sensitivity) even large-scale deployment of CDR might not restrain temperature increases, sea-level rise and precipitation changes to safe levels. From this perspective we cannot know if SRM might not be essential also. Yet pursuit of CGE might undermine the basic essential of accelerated emissions cuts. This generates something of an ethical dilemma: CGE technologies may be necessary to avoid dangerous climate change, and they might particularly benefit many of the poorest and most vulnerable to climate impacts (as noted in Chapter 1), yet developing them would appear to facilitate further delay in emissions cuts, thus increasing the risk of dangerous climate change and exacerbating climate injustice (*Paper 1*).

I argue that the way to cut this Gordian knot is to prioritize efforts to transform the social imaginary, including forms of climate politics that stimulate cultural and behavioral responses as well as technical ones; rather than continuing a quest for technical solutions that sustain the underlying imaginary. In addition, as I argue in Chapter 5, a political approach to justice as recognition is fundamental to a transformation of the social imaginary

that would encompass restorative climate justice. In such a transformed world, the climate and economic inertia of the system might still necessitate the development of CGE techniques, but I anticipate that CGE would take very different socio-technical forms in such a future. I do not object to CGE research continuing in the interim, but suggest that in the interests of justice, it requires careful regulation, precaution and a high level of reflexivity in the research community to ensure that it does not simply help lock in undesirable and unjust outcomes. In the dominant social imaginary CGE researchers cannot isolate themselves from the political economy of climate change.

The CGE research field has grown rapidly in the past decade. Until 2006, there was relatively little activity, and even perhaps a self-imposed 'taboo' on CGE scholarship, motivated by fear of a moral hazard effect. More recently, research has been framed by ever more intense scientism of carbon budgets and planetary boundaries, in a narrative of the transition to a planetary Anthropocene. As Stilgoe (2015) points out, the discursive shift is itself telling, implying the relinquishing of an emotional and irrational "taboo", in favor of rational, managerial, scientific analysis – which continues to largely ignore the political economy of climate change. It also highlights CGE's tendency to endorse a limiting and harmful 'fact'-'value' dualism. Moreover, research increasingly naturalizes and normalizes CGE both as 'a thing in the world to be examined' (Stilgoe, 2015:8) and also as in making it normal and unexceptional. As Stilgoe argues:

> "geoengineering researchers have become increasingly self-confident. Doubts, uncertainties and ambivalences are being tamed. Ethical and political quandaries are being turned into empirical questions. Extraordinary proposals are being domesticated with ordinary science. The ease and cheapness of geoengineering is often taken for granted in geoengineering research. Geoengineering is often talked about as though it is an inevitable part of humanity's future relationship with the planet, and sometimes talked about as though it is already possible" (2015:11).

4.2 Power, climate politics and the moral hazard

This section unpacks the political nature of moral hazard and its relationships to our understandings of power, and to the dominant social imaginary, within with CGE is being incorporated. Table 4.1 summarizes the arguments of the section, indicating which relevant issues are raised in each of the papers.

Table 4.1 Mitigation deterrence and the justice of CGE

	Understanding mitigation deterrence	The co-creation of mitigation deterrence in socio-technical systems	Mitigation deterrence as a justice concern
Paper 1	Outlines definitions and disciplinary variation in interpretations. Highlights political forms of mitigation deterrence.	Illustrates mitigation deterrence as a coproduced-function of discourses about the technologies and the goals of climate action	Sees mitigation deterrence as intergenerational injustice, in part resulting from discourses of climate risk rather than climate justice (largely ignoring difference)
Paper 2	The 'climate risk' focus of modeling and use of inappropriate (business as usual) counterfactuals both sideline moral hazard	The epistemic domination of the risk imaginary is illustrated by the hegemony of modeling as a means of quantifying risk in climate policy	Moral hazard effect reduces corrective justice potential of climate policy
Paper 3	Highlights political not individual forms of moral hazard, as reason for concern	Reveals public expectations of and concern over political moral hazard	Public concern over injustices of moral corruption and environmental dumping
Paper 4	Suggests moral hazard is generated in discourses and framings, notably a misplaced technological optimism, and carbon commodification	Discourses revealed as vehicles of socio-tech systems; and in this case as sustaining of (neo-)liberal global capitalism (and the dominant social imaginary).	Moral hazard redistributes risk to future generations and other unrecognized groups
Paper 5	Highlights hubris of climate 'restoration' as a source of moral hazard in contrast with the humility of repair ethics found in more mature disciplines	Considers risks of 'repair or restoration' as a justification for continuing harm (a variant of moral hazard)	Highlights hubristic Anthropocene constructions of a single, powerful humanity (failing to recognize difference).

Climate geoengineering technologies – especially SRM variants - promise great technical leverage (large impacts on the climate from small material inputs). The dominant imaginary is one of potency (Stilgoe, 2015). With great power comes great responsibility. Ethical exercise of power requires (procedural) accountability. But with the indeterminacy of climatic effects, and the emergent and co-produced nature of CGE impacts standard approaches to procedural justice in which affected parties can challenge decisions (McLaren

2012b) are clearly insufficient alone. In particular, structural power expressed as habitus provides only a vague concept of specific agents which could be held accountable through standard procedural justice processes, or even through conventional political mechanisms. Yet, as suggested earlier, there is clear collective culpability and complicity for climate impacts vested in particular groups within global society.

In the case of climate change the world's elites already hold power over the poor and vulnerable, now and into the future, largely determining the conditions in which the poor might live. So far societies have done little to build mechanisms of accountability (or to co-produce practical ethics) for such collective power, especially at international and intergenerational scales. In the global North we still struggle to understand or acknowledge our complicity arising from the benefits we obtain from unjust global systems. In the climate context, rather than changing our behaviors, we seek novel abatement technologies (from wind energy to nuclear power) and adaptation measures (sea walls and floating cities) as substitutes for aggressive emissions cuts achieved by reducing consumption. In this light all discussion of geoengineering is a sign of our collective ethical failure to achieve adequate progress on climate mitigation.

Solar Radiation Management (SRM) geoengineering in particular appears to offer the potential of more rapid, and perhaps more targeted, control over future climates. But because of its great leverage, it threatens to concentrate power even further. This raises critical questions about in whose interests it might be deployed. And whether those interests might extend to it being deployed as a substitute for further, or accelerated mitigation, rather than as a supplement.

Mitigation deterrence

I do not seek to imply that CGE is somehow the product of a conspiracy to derail mitigation (not even in the same way that denial might be seen as a product of active, interested interventions to protect financial interests and sustain ideological values), and nor does this imply that the vast majority of CGE researchers would in any way subscribe to such goals. I argue merely that the currently globally dominant social imaginaries, discourses and narratives make it simultaneously almost inevitable that CGE would in part replace or deter mitigation, and discursively conceal such substitution behind apparent practical limitations to mitigation. In other words beliefs and judgments on the potential for mitigation are being reconstructed to levels that fall short of what might have proved possible in the absence of CGE. *Paper 4* reveals discourses of CGE that are sustaining of (neo-)liberal global capitalism,

and thus strongly motivating mitigation deterrence (understood as implying research or deployment of CGE as an alternative to mitigation and adaptation).

Mechanisms that could generate mitigation deterrence act at multiple levels. One of the simplest is research opportunity costs (if marginally less resources are put into research on, say reducing emissions from transport by traffic restraint; and marginally more into CDR technologies; then the relative apparent potential of the two responses will change – most likely to imply less traffic restraint and more CDR). The classic political moral hazard (Corner and Pidgeon 2014) is particularly of concern: we know politicians see mitigation (especially through behavior change) as hard and unpopular – so any excuse to do less or postpone such action seems likely to have a marginal effect (but if the prospect motivating this is itself politically unpalatable, but not required today – like SRM, we can also expect politicians to deny and conceal any such impact).

In addition, we can reasonably predict that more climate skeptics will perform what Morton (2015) christened the Superfreak Pivot – a shift from climate denial to support for SRM – grounded in a resistance to mitigation as too expensive and too great a constraint on (particularly economic) freedoms, and a perception that SRM could offer a cheap and effective alternative (as suggested by Levitt and Dubner (2009)). The prospect of such advocacy finding a place in any Governmental discourse perhaps seemed remote and academic before the election of Donald Trump. Now it would seem to worry even many of the scientists involved in CGE research.

Vested interests

Evidence from (limited) public engagement, such as that reported in *Paper 3*, suggests that while publics understand that scientists are ethically motivated to work on CGE as a response to climate change, that alone doesn't guarantee that it would therefore be deployed in ways that help deliver a just response. Put simply, scientists don't make the political decisions involved. The UK publics reported on in *Paper 3* appeared more aware of the cultural, economic and commercial interests at play in the climate debate than many CGE researchers. Amongst other things, they resisted the prospect that geo-engineering technologies might be developed and deployed in the interests of the same corporate interests that have driven fossil fuel use, and worried that such interests could distort genuine scientific endeavor.

The concerns about vested interests reported in *Paper 3* were strong for all forms of CGE. Unaccountable power (whether corporate or governmental) was widely perceived, and

raised concerns that decision makers would grasp CGE as some sort of easy option (a form of moral corruption as described by Gardiner 2006, 2010), and that any downsides would be externalized. In particular publics raised concerns of environmental dumping (in this case of carbon storage for CDR) on poor and powerless communities. In these ways publics were – in this deliberative setting – exposing and exploring some of the problems of the dominant social imaginary, yet they also consistently expressed expectations that the outcomes would be in line with how the world is seen to work (in the interests of elites) within that imaginary.

Within the deliberative events reported in *Paper 3*, publics tended to express some technological skepticism about CGE. Yet, as *Paper 4* finds, technological optimism is a key discursive framing of CGE, as it is also of the modern social imaginary. The technologies are discussed in ways that make them seem effective and controllable, rather than as imaginary and uncertain, thus increasing the risk that they could be adopted or promoted as substitutes for mitigation.

Moral hazard as a co-production

CGE advocates tend to respond to concerns of moral hazard by clarifying that they see the technology only as a supplement to mitigation. Yet there are multiple reasons to believe that such assertions would not be performative. First, as noted above, the researchers are not the ultimate decision makers here. Second, people are subject to all sorts of cognitive biases. And third, as discussed in Section 2.4, all technologies – from guns to seatbelts - form part of socio-technical systems. Technologies therefore affect people psychologically and culturally in ways that can produce unforeseen and even perverse results. Notably they can reshape how people perceive and react to risk. For example, people buy guns to protect themselves: yet controlled epidemiological studies show that those who carry firearms are more than four times more likely to be shot than those who do not (Branas et al 2009). One reason is the psychological over-confidence that comes with carrying a weapon. Believing themselves somehow 'insured', gun users take much greater risks, and get into dangerous situations that they would have avoided if unarmed.

CGE technologies, even if we disregard fears of military applications, share some interesting characteristics with guns: people demand them because society has collectively failed to prevent the emergence of a major risk to society. Actors who have them might understandably then argue against risk prevention, as they both feel personally safer, and see the technology as protecting important lifestyle, social or market freedoms and rights.

This is only one possible technology analogy amongst many, but helpfully illustrates the socio-cultural embeddedness of apparent technological requirements, and the way in which a technology implicated in serious social harm (elevated death rates with an uneven racial distribution) could nevertheless be defended as part of a dominant neo-liberal ideology. To extend the analogy, one might suggest the equivalent of mitigation for crime prevention is an accountable public police force, supplemented by community level crime prevention investments. What would be the implications of increasing gun ownership in the context of rising crime in such a system? Would it merely supplement, or undermine the existing system? While notionally credible as a supplement, two factors at least would appear to suggest substitution. First, high gun ownership, heavily armed police, and the increased risk of shootings by police would threaten to undermine community relations and heighten tensions, making community crime prevention difficult (in the way CGE might undermine international collaboration over mitigation). Second support for public funding for police and crime prevention (and for effective gun regulation) would likely fall amongst gun owners (at least where libertarian cultural discourses are strong). This latter resembles the ways in which opposition to carbon taxation or regulation is high amongst CGE advocates.

Moreover, the use of such a technology may both become locked in, and lock in other choices which increase risk: in a society with widespread gun ownership the gun lobby becomes a powerful actor against gun control, and the police must be routinely armed with fatal consequences for certain minorities. With a climate policy reliant on SRM, the termination problem (the potential for rapid climate impacts arising from the otherwise masked climate forcings) makes stopping extremely challenging in the absence of effective decarbonization, while the idea of the technology makes it politically easier for the fossil fuel lobby to encourage continued extraction and use of fossil fuel – exploiting the benefits of sunk investments - despite this also having unfairly distributed impacts.

This arises even with CDR: for example, one case for CDR is sometimes expressed as a means of reducing the financial and economic risks in the transition to the low-carbon economy (in other words avoiding fossil assets becoming stranded by offsetting their use now or in the future). More generally, if CDR is incentivized by trading the carbon involved in carbon markets, the result is that its deployment is automatically offset by reduced mitigation effort (unless the cap on the market is equivalently reduced) (McLaren 2012a). The idea of CDR, supported by initiatives such as the Virgin Earth Challenge and the X-Prize for carbon capture and utilization, has perhaps too easily captured imaginations (McLaren, forthcoming). The discursive narrative of a green economy or ecological modernization

described in *Paper 4* rather too easily validates ideas of carbon utilization (in synthetic fuels, for atmospheric enrichment in greenhouses, or in building materials, for instance) that might facilitate the development of carbon withdrawal technologies, but which in use would merely recycle carbon back into the atmosphere (again acting as offsets, rather than carbon removal techniques). In other words, deployed within the discourses and imaginaries of ecological modernization and carbon commodification, CDR is highly susceptible to moral hazard. Moreover, as already noted, the introduction of BECCS into carbon pathways models has facilitated political commitments to mitigation levels that remain insufficient (Geden 2013, 2015, Anderson 2015).

Mitigation deterrence or substitution, and the social imaginary

In various ways therefore, there are forms of moral corruption (Gardiner 2010) or 'moral hazard' (Lin 2013) associated with both categories of CGE technologies. Gardiner's analysis suggests that actors are biased towards policy approaches that happen to match their existing interests and values, regardless of whether they are effective at reducing climate change or enhancing climate justice. Such moral corruption may then be an endemic feature of the dominant social imaginary, which validates ideas of enlightened self-interest, and rational individualism. Even if this is not the case, our social imaginaries of the world and future, and the associated ways we understand climate change and its causes are significant in whether moral hazard or moral corruption arises in practice. As *Paper 1* argues, mitigation deterrence appears differently depending on one's understanding of the nature and mechanisms of the climate change problem: insofar as the problem is seen as one of risk management, in line with the dominant social imaginary, fears of moral hazard are more likely to be dismissed and substitution of CGE for mitigation permitted, than if the issue is understood as one of justice. In ethical evaluation, both ends and means can matter, but I would argue that 'a hospitable climate' is not ethically an end in itself, but a means towards a just and sustainable society (perhaps even, as Holland (2008) argues, a metacapability). In that case, how climate hospitality is achieved matters intensely. Considering merely climate risk rather than climate justice not only contributes to misplaced beliefs of substitutability, but also to the problematic universalization of humanity in Anthropocene discourses elaborated in *Paper 5*. Other mechanisms promoting misplaced perceptions of substitutability include modeling practices such as inappropriate counterfactuals. By presenting CGE scenarios in comparison with high emissions, or even business as usual scenarios, modelers make their task of analysis and attribution easier, (by contrast with using more realistic counterfactuals of accelerated mitigation) but - as discussed in *Paper 2* -

frame the possibility of CGE as a substitute for effective mitigation, rather than a complement to it.[12]

The injustice of substitution

If CGE is treated as a substitute, there are several possible injustices that might arise, be exacerbated, or go un-restituted. These include distributional, historic and future injustices. First, distributional injustices may arise from the impacts of novel climates as opposed to better restored ones, or from the consequences of distributed impacts of land, resource, or storage needs for CDR (such as from conflict over land use) (McLaren 2012a). In these cases, as discussed in *Paper 2*, recognitional justice is also essential to acknowledge the effects of difference in vulnerability and preferences. Second, mitigation policy, with its focus of common but differentiated responsibility imposing greater burdens on the high consumers of the rich world, offers a route towards restitution for historic injustices – not only those of uneven fossil fuel extraction and use but also those more generally of industrialization, colonialism and slavery. Moreover, in radical climate justice accounts restitution for such impacts comes to the fore, but such approaches would appear even less likely to be pursued than at present, if CGE – with its industrial logic and concentration of power - is substituted for mitigation. And third, there is potential for grave intergenerational injustice if CGE doesn't materialize or work as predicted (*Paper 1*). In this case an increased burden of climate harms is imposed on future generations without any offset from CGE technologies. More generally, as *Paper 4* suggests, moral hazard tends to redistribute climate risk to unrecognized groups (including future generations).

Even before the technology exists in practice there is potential for moral hazard (perhaps even greater as the gap between the perceived and actual substitutability of CGE (especially SRM) and mitigation and adaptation can be greater (*Paper 1*)). While the technology is entirely imaginary there is also an extreme effect of technological optimism as a dominant frame (*Paper 4*): this increases perceived substitutability by giving the impression of practicality and controllability (*Paper 2*). And in this period where technologies are under development and seeking funding, developers face very real pressures to overpromise in terms of technical and commercial performance. For instance the value of CO_2 as an input

[12] I return to the practice of modeling, and how it reflects the dominant administrative social imaginary in the next section.

for enhanced oil recovery – around $50 per ton – appears to have stimulated developers to imagine business models and technological designs that could claim to achieve such a price, even where independent assessments suggest it to be unrealistic (McLaren 2012a, forthcoming). Moreover, the hubris of functional 'climate restoration' as a discourse, as described in *Paper 5,* contrasts poorly with the humility of more developed repair ethics found in other disciplines. The idea that such climate restoration might be achieved through CGE, rather than running into recalcitrant reality – as other disciplines have encountered – would again appear to fuel a moral hazard effect. And even if the techniques could be relied upon, *Paper 5* also notes how improved capabilities of restoration in other arenas – such as ecosystem management – can be actively deployed to justify further damage to ecosystems (by mining, for example) conditioned upon subsequent restoration (or habitat creation as a form of 'substitution') that either fails to materialize, or even if deployed, acts to ethically 'denature' the affected site.

Mitigation deterrence and moral character

For a whole range of reasons, therefore, a dangerous temptation remains of treating CGE, and particularly SRM, as a possible savior and an excuse to further delay even cost-effective mitigation. Might relevant decision makers and politicians be tempted? Researchers have been quick to downplay the effects of poor character on moral hazard (e.g. Hale 2012, Keith 2013, Reynolds 2014). But as expenses and lobbying scandals repeatedly reveal, political and corporate elites are susceptible to temptation, and - according to psychological research - more likely to cheat and act unethically than poorer groups in society (Piff et al 2010). And in other experiments, people with 'self-enhancing' values - those that relate to the accrual of wealth, power or status to oneself - were found to be more vulnerable to the moral hazard in geoengineering (Corner and Pidgeon 2014). So we should perhaps be concerned about whether the relevant decision makers have the necessary moral character (or virtues) to take tough decisions on mitigation and adaptation in the face of more pressing climate impacts, rather than adopting the prospect of geoengineering as an excuse for not upsetting political allies, campaign funders or swing voters. Such a 'political' moral hazard seems a bigger reason to worry than the idea that ordinary individuals might relax their efforts to cut emissions. Indeed, it is possible that many ordinary people might see geoengineering as so wacky and unpalatable that they increase their support for mitigation – the so-called 'negative moral hazard' or galvanization effect. *Paper 1*, and *Paper 3* both indicate more public concern over political moral hazard than individual, but also note that the evidence for individual galvanization effects is still rather limited.

This section has explained mitigation deterrence as mechanisms by which consideration of CGE discourages adequate mitigation. Such mechanisms are a product of emergent effects of socio-technical systems exacerbated by poor character and where power is asymmetric. Mitigation deterrence is a serious justice concern insofar as mitigation brings justice benefits that CGE does not (these include restorative justice benefits), or more fundamentally pushes transformation of unjust economic and political systems that are otherwise sustained in the face of climate change by CGE. The next section turns to the way CGE reframes and constrains justice as it reinforces the depoliticizing tendencies of the dominant social imaginary.

4.3 Depoliticization and the re-framing of justice

This section describes the technocratic and post-political framings of CGE, and discusses how they limit consideration of justice, particularly highlighting how depoliticization drives out consideration of restorative justice goals. Table 4.2 summarizes the arguments of the section, indicating which relevant issues are raised in each of the papers.

As *Paper 4* summarizes, CGE is primarily framed as a technological response to climate change, and in this respect it builds on and extends existing climate change discourses of ecological modernization and technological prometheanism, which share a technocratic, and post-political approach, in which risk is managed through technological, administrative and market-based tools, and the apparent disruptions and disjunctures of climate change in the Anthropocene are tamed. As Swyngedouw (2010) suggests, such discourses enlist a discursive catastrophism to justify an incremental administrative response. Stirling (2015) argues further that typical Anthropocene discourses not only suggest controllability (of earth systems by humanity), but in framing the alternative as catastrophe, they encourage an authoritarian depoliticization of climate policy. I argue in Chapter 5 that a political concept of justice as recognition can help challenge such framings, if only by rejecting the universalizing effect of the Anthropocene framing, which tends to unify humanity, rather than recognizing difference and inequality.

Table 4.2: The framing out (or narrow construction) of justice

	Diverse conceptions of justice	The ahistoric clean sheet framing	Framing out by post-politics
Paper 1	Describes mitigation deterrence as a distributive justice issue	Highlights difference between risk management and justice as goals for climate policy	Climate risk as a 'post-political' managerial concept; as opposed to justice as a subject of political debate.
Paper 2	Exposes presupposed consequential justice concepts in models, and lack of recognition of vulnerability	Reveals forward looking models with no historical narratives; presents a practical example of the clean sheet	Identifies technocratic approach to risk and a managerial construction of CGE (overlooking questions of power)
Paper 3	Plural concepts of justice emerge in deliberation (distinct from those found in philosophical or political debate)	Publics recognize problems of established power relations, and reflect conceptions of justice as corrective too	Power and interests are central to public conceptions of justice. Publics also demand participation.
Paper 4	Particular concepts of justice are presupposed in key discourses of ecological modernization and prometheanism	The 'clean sheet' is central to post-political framings of CGE. Injustices of neo-liberal capitalism go unchallenged	Post-political constructions of climate change and CGE and particularly catastrophism are building blocks in post-political discourses.
Paper 5	Highlights restorative justice, recognition and care as forms of justice	Critical importance of legibility to reversing clean sheet effect; and of restorative / corrective forms of justice.	Repair as political or transformative (rather than conservative / sustaining)

A post-political technology?

In its harnessing of catastrophism, CGE exemplifies the contemporary 'post-political' trend of 'technological solutionism' (*Paper 4*). There is an element of the CGE literature which suggests a principal advantage of SRM CGE (at least) is that it is not bogged down in international climate politics, and thus would somehow be easier and quicker to deploy (e.g. Lomborg 2010; Lane 2013). However, the implications of avoiding climate politics would not be uniformly positive. It might become instrumentally easier to tackle climate risk, but this implies an approach to justice determined not through international negotiation and dialogue, but by fiat, from whichever country or group designs the SRM interventions (*Paper 2* discusses some of the implications for justice of possible choices of design). Such

domination is no more just or ethical than ideas of benign slave-owning or colonialism in the best interests of the colonized (Smith 2012). Moreover, from the foregoing (Section 4.2) it would seem that evading political accountability would risk a form of climate policy highly distorted by moral corruption.

Combined with the asymmetric power implied by CGE (as discussed in the last section), an extreme post-political framing of CGE is one that endorses unilateral implementation. Advocates suggest that, because of its high leverage and low cost, SRM could somehow sideline politics and provide a silver bullet (Lane 2013, Levitt and Dubner 2009). It has even been suggested that SRM might be deployed by a single actor: a rogue geoengineer, or a 'climate vigilante' – a Tony Stark or Bruce Wayne figure with money and a singular view of justice (Victor, 2008). I refer to superhero culture deliberately here, because it also reveals the ethical dilemmas in vigilantism: the tension between justice and the rule of law. Stories of the Dark Knight (for example) illuminate the need for oversight, accountability and civil liberties - even, or perhaps especially, in times of crisis. They also remind us that while public sympathy for vigilantism signals that something is wrong with the system: this does not make the vigilante's actions right or ethical. Put bluntly, just because climate policy and governance does not work presently, this alone does not make geoengineering – even with democratic oversight - the right answer. In Gotham the need is to eliminate the corruption that enables criminality to flourish, not to give policemen license to emulate Batman and terrorize criminals. In practice, fortunately, unilateral geoengineering – whether by states or philanthropists – seems implausible (Horton 2013, Corry, in press). Yet claims or implications that SRM is a high leverage, low cost, apolitical technology persist (See *Paper 4* and Lomborg 2009, 2010, Lane 2013, Barrett 2008, Davies 2013, Keith 2013). In this context, if SRM were to become bogged down in global negotiations, it is not inconceivable that powerful actors might be tempted by 'emergency' rhetoric to avoid due process and even reproduce a 'state of emergency' (Markusson et al 2014, Sillmann et al 2015). It is therefore important to surface the possible implications of framing CGE as a 'technical solution'. Arguments that CGE is a shortcut around UNFCCC political roadblocks; and a means to avoid the need for messy and difficult behavior change interventions will inevitably co-construct such perceptions, especially in the context of moral hazard or moral corruption noted previously.

Such depoliticization is not limited to SRM, as highlighted by the concerns over accountability for all CGE technologies reported in *Paper 3*. The way in which CDR has been introduced to climate policy by analysts and modelers as a device to make policy pathways compatible with global temperature targets (Geden 2013, 2015) offers a striking illustration

of the way in which decisions in this arena can become technical - and the political and social challenges of practical implementation (such as the implications of growing demand for biomass and land for BECCS or other biotic CDR) become at most technical criteria, despite political contestation by local communities and NGOs. This also illustrates one way in which 'post-political' framings of CGE act to contribute the risk of moral hazard or mitigation deterrence (in this case, the addition of CDR to the models and pathways justifies continued inadequate mitigation). While it might appear unlikely just now, the prospect of a similar manoeuver with respect to SRM has been enabled by the shift (in the UNFCCC regime) to a headline temperature target, rather than a carbon budget. In coming years, should mitigation remain inadequate, we should recognize that modelers may be tempted to introduce SRM to the models as 'the only way to get the figures to add up' to meet global temperature targets; without genuine political debate. The power of modeling, as opposed to democratic politics, to shape policy, and its hegemony as a means of quantifying risk in climate policy (Demeritt, 2001) (and with respect to CGE) is testament to the power of the dominant administrative risk imaginary described by Groves (2014). The epistemic domination of modeling and the risk imaginary is exemplified by the extent to which models are treated in the published literature as truth machines, rather than experimental sandpits (as seen in *Paper 2*). The result is that other ways of interpreting the effects of CGE go unrecognized, in a form of epistemic injustice.

Modeling and the politics of justice

Modeling also tends to exacerbate perceptions of SRM as cheap and high leverage, portraying SAI in particular as a highly controllable technology. The scope for tweaking climate models in ways intended to simulate different forms of SAI gives a misleading impression of a technology that can be controlled and modulated over time and space to achieve highly targeted climate outcomes (see *Paper 2*). *Paper 2* unpacks the technocratic approach to risk and managerial construction of CGE (and indeed of CC more generally) embodied in a range of modeling techniques, approaches and assumptions. Such a construction of the issues avoids examining the nature and distribution of power, implying rather a single benevolent social manager (a typical consequence of the dominant administrative social imaginary). At the same time this contributes to the misrepresentation of a single global humanity in the context of the climatic Anthropocene.

The literature is not entirely unreflective of such concerns. Heyen et al (2015) offer a strong critique of many modeling approaches arguing that small changes in assumptions about interests or vulnerability of affected populations could generate substantial differences in

interpretation. But, as I argue in *Paper 2*, considering vulnerability and diverse interests is not just a reason to refine models within the dominant social imaginary. It is an argument for using them in altogether more experimental, accountable and epistemically diverse ways. *Paper 2* particularly suggests integrating models with public deliberation, to help devise different scenarios, enhance accountability and generate reflexivity in the research community. Even with the acknowledged limitations of public deliberation regarding emerging technologies, this would seem to offer scope to begin to challenge the limits of the dominant social imaginary.

The shortcomings of modeling are not just practical (and given endemic uncertainty, probably irresolvable (Groves 2014, Stilgoe 2015)); they have deep ethical implications. In particular, CGE modeling as practiced today tends to co-produce narrow utilitarian and liberal constructions of justice, and helps construct a clean sheet framing which overlooks historic injustice and the restorative justice demands that in turn implies.

Paper 2 exposes embedded (presupposed) utilitarian and consequential justice concepts in models. These are broadly the same approaches identified in *Paper 4* presupposed in discourses of ecological modernization and technological prometheanism. They are all rooted in (neo-)liberalism, albeit with a noticeable contrast between more libertarian promethean concepts, and more classically liberal consequentialism, with a clear acceptance of a role for the state in ecological modernization. But all of these presupposed forms of justice contrast starkly with those emergent in consideration of restoration and repair in *Paper 5* which are care-based, restorative, founded in recognition (including forms of 'legibility' described in the paper) and which in many respects draw more on virtue ethics than on consequentialism or deontology. Sandler (2005) outlines the emergence of environmental virtue ethics, in terms of norms of character, both as a source of ethical understanding of how humans should relate to the environment, and as a source of guidance for norms of action. Virtue approaches can be found underlying modern communitarian thinking (Sandel, 2009) as well as care ethics (Held 2006, Tronto 1993), and in analysis of the challenges of climate change (Hulme 2009, 2014).

The clean sheet

Restorative justice is also framed out by risk management approaches to CGE, which whether as a partial or complete substitute for mitigation tend to suggest a 'clean sheet' in which justice matters only as a current and future distributional issue, rather than as a historical context for the problems we face (as if a clean sheet has been drawn over past

inequalities and infidelities, and a new social contract is being drawn up from scratch). *Paper 4* suggests that the 'clean sheet' is central to post-political framings of CGE, and to approaches in which injustices of neo-liberal capitalism go unchallenged. The clean sheet is a product of post-political ideologies, silence about power, and persistent comparison of climate engineering with unabated climate change (rather than with the outcomes of other climate responses). In this context even equal rights, as a proposal for the future, act as a smokescreen concealing the need for backward looking restorative justice (Meister 2011). In the climate case, such restorative justice might encompass accelerated mitigation paid for by those complicit in climate colonialism, and measures such as repayments of the climate debt (McLaren 2003), and reparations for slavery and colonialism.

In particular the clean sheet is a product of the forward looking models with no embedded narratives revealed in *Paper 2*, which, for example, typically present counterfactual scenarios with a quadrupling of carbon dioxide levels as both inevitable and unintentional (thus carrying no moral culpability or complicity!). *Paper 1* also highlights the difference between risk management (purely forward looking) and justice (also historically rooted) as goals for climate policy, and also suggests that as a goal, climate justice could fundamentally challenge neo-liberal global capitalism (and thus the dominant social imaginary). Moreover, risk (as considered in the moral hazard literature reviewed in *Paper 1*) is clearly a 'post-political' managerial concept – in the forms Groves (2014) links with ideas of the 'risk society'; contrasting strongly with justice as a subject of political debate and contestation.

Restoration and repair

The clean sheet completely rejects ideas of restorative justice, turning climate restoration into a physical, environmental and technical question. Yet in climate change, as in other social concerns, justice is profoundly affected by past inheritances (of depleted resources, or of wealth from past exploitation). *Paper 3* indicates that publics (in contrast to the modelers) recognize problems such as environmental dumping as part of established power relations, and express conceptions of justice as corrective too (see below: 'Public engagement'). But public engagement alone cannot adequately 'dirty' the sheet, although it would help, especially if extended internationally. *Paper 5* suggests that development of a practical ethic or virtue of 'legibility' (a form of recognition of past injustice and its effects in which the historic identity narratives of subjects and objects alike are made clearly visible) would be critical to reversing the clean sheet effect. In turn this would underpin prospects of restorative or corrective forms of justice including reconciliation. In this setting, *Paper 5* argues that repair can be a radical political or transformative approach, rather than being

conservative or sustaining of the dominant social imaginary. Understood this way, repair is the flip side of a political concept of recognition enabling dissensus (see Chapter 5).

By contrast, instrumental ideas of repair (also discussed in *Paper 5*) reflect a dangerous hubris. Attempts (even in models) at the technical reconstruction of the broken climate system, with imaginary technologies (the 'perfect particle for SAI (Keith 2013)) that leave no trace of their actions ('invisible', rather than legible mending), tend to exceed even the models ability to respond. But again this is not simply a technical matter to be addressed with more research and more computing power. Understanding the limits to understanding is critical. I argue that humanity also faces a "control dilemma". Discourses of the 'Anthropocene' give a misplaced confidence in the controllability of earth systems (Baskin 2015, Hamilton 2013, Moore 2016). *Paper 2* discusses the imagined control, monitoring, attribution and feedback techniques and technologies that would be required to deploy SRM geoengineering in targeted and modulated ways, suggesting that these Promethean narratives make false promises in the light of the deep uncertainties and indeterminacy of the interrelated socio-economic-technological-climate systems. As Hulme (2014) points out, climate control through CGE is a multi-disciplinary control problem with rapidly multiplying degrees of freedom, preventing control, let alone optimization of regional or local weather outcomes. This has serious consequences for the prospects of managing distributional concerns arising from climate change through CGE (even if the technologies function on a gross scale to cool the Earth). It also illustrates how such co-produced technological imaginaries of power and control are central to the administrative social imaginaries through which modern society seeks to manage future uncertainty. Moreover, if humanity places greater reliance on anticipated geoengineering, but it fails to deliver, humanity is unlikely to be able to compensate by then accelerating mitigation and adaptation. Yet if geoengineering does deliver, human technological hubris would likely be fueled, potentially exposing future people to new, greater environmental challenges, and increasing collective reluctance to tackle injustice and unsustainability by political and cultural routes.

Public engagement

In several places above I have gestured at a possible role for public engagement in enhancing the accountability of research, in expanding the concepts of justice considered, and in general in re-politicizing discourses over new technologies. This suggestion reflects something of a participatory turn in innovation (Chilvers and Kearnes 2016), which has partly informed a broader discourse of responsible innovation (Owen et al 2013, Stilgoe 2015). Responsible Innovation implies improving not only public inclusion, but also enhancing

anticipation, reflexivity and responsiveness (Owen et al 2013). Given the findings of *Paper 2* on the modeling literatures and the implications discussed above, responsible innovation principles would appear to be needed in CGE research.

Public engagement around emerging technologies can be understood as a form of procedural justice, providing opportunities for public participation. It also implies a liberal form of recognition of different views and values, largely within the dominant social imaginary. The main potential downsides of public engagement are that with emerging technologies such as CGE it might contribute to undesirable or premature normalization of the novel technology; and that it risks constituting a previously non-existent public around the new technology in ways that are unhelpfully shaped by the extant technological imaginaries (Chilvers and Kearnes 2016, Bellamy et al 2013; Bellamy and Lezaun 2015) as briefly discussed earlier (Section 1.2). As discussed further in Chapter 5, to engage unreflexively with such a public would be a form of mal-recognition, creating rather than recognizing identities, and reifying the unconscious and unintended framings and biases of the conveners and facilitators. Yet public engagement can also constitute an effort to challenge and resist depoliticization of science – opening it up to 'outsiders' (Young 1990).

Indeed, as *Paper 3* shows, reflexive and well-managed engagement can begin to open up such spaces. The engagement exercises reported in *Paper 3* revealed plural concepts of justice emerging in deliberation. And these plural concepts are distinct from those typically presented in philosophical or political debate within the dominant social imaginary. *Paper 3* also revealed the ways in which power and interests are central to public conceptions of justice. Publics also demand participation as a form of accountability, which makes the responsible constitution of participation in ways that minimize the structuring effects of the technological imaginary all the more critical.

Such continued 'opening up' of the geoengineering debate needs to show recognition and respect for diverse cultural values, which might suggest observing and analyzing agonistic forms of participation (such as campaign protests) in addition to dialogic, invited forms like engagement events. Researchers must be aware that public engagement can itself serve to depoliticize an issue – insofar as it replaces, rather than complements political debate. And that public engagement can constitute a managerial space of post-politics if it is limited to invited participation on terms set by, and in the language of, technical experts.

I argue in the next chapter that properly inclusive politics would involve not just participation and engagement on the liberal model, but recognition and representation of

diverse interests on their own terms as a way of transforming political debate, content, institutions and processes. As suggested above (Section 2.5) and argued further below politics is a process of widening inclusion and dissensus – simultaneously (re)defining justice, and contributing to it.

This section has examined ways in which CGE discourses contribute to a depoliticization of the climate, de-emphasizing or framing out many aspects of justice, especially on the recognitional and restorative dimensions. It has suggested ways in which enhanced public engagement in research might help widen justice considerations, but also how engagement might perversely serve to exacerbate depoliticization. It has restated the significance of recognition of difference for both effective participation and for justice. The next section discusses in more detail some of the ways in which misrecognition arises in CGE, in particular in the contrast between risk and vulnerability.

4.4 Risk, vulnerability and misrecognition

This section explores distinctions between risk and uncertainty, especially with respect to the future; and to the implications of differential vulnerability. It emphasizes relationships between recognition, solidarity and restorative justice. Table 4.3 summarizes the arguments of the section, indicating which relevant issues are raised in each of the papers.

Paper 1 highlights the distinction of risk and justice as policy goals, with the former based on a consequentialist assessment of predicted climate impacts, and the latter bringing questions of differentiated culpability, complicity and accountability to the fore. A justice perspective raises fundamental questions about interdependence in climate policy. As Hourdequin (2012) argues, mitigation in particular implies mutual solidarity, while in different ways both adaptation and CGE (especially in SRM forms) imply the potential for divergent responses. But where adaptation's most likely injustice is that rich countries might enjoy greater capacities to adapt than poorer ones, SRM rather implies that the climate interests of richer countries would be imposed globally (including both benefits and disbenefits arising in different locations). Yet within the dominant social imaginary, CGE and adaptation (and in many respects, even mitigation) all deploy an idea of risk as quantifiable hazard, rather than acknowledging uncertainty and ignorance (Stirling 2003). In the case of SRM at least, the consequences of this are potentially severe. Such a form of risk analysis acts to assume away uncertainties in technologies, models and in monitoring and control techniques which seem likely to mean that at best, the distributional consequences of SRM

are unpredictable, while at worst, the delivery of even specific global average climate outputs would be compromised (*Paper 2*).

Table 4.3: Risk, vulnerability and solidarity

	Risk, vulnerability and resilience	**Uncertainty and vulnerability**	**Interdependency, solidarity and restorative justice**
Paper 1	Highlights distinction of risk and justice as policy goals	Uncertainty of SRM makes moral hazard a threat to those most vulnerable to climate impacts	Raises questions about interdependence in climate policy (cf Hourdequin 2012)
Paper 2	Risk analysis assumes away uncertainties in technologies, models and in monitoring and control techniques. Approach is ahistoric, and unsituated	Uncertainty exacerbates vulnerability. Modeling fails to account for differences in vulnerability, preferences and values	Recognition of variegated vulnerability and interests underpins the possibility of solidarity and restorative justice.
Paper 3	Publics identify and fear vulnerability to powerful interests	Publics recognize uncertainty and expect indeterminacy in CGE implications	Publics express solidarity (and acknowledge division)
Paper 4	Dominant discourses largely ignore vulnerability and resilience, but focus on risk management	Discourses constitute engagements with uncertain futures (in turn co-creating those futures)	Discourses are internationally divisive (sustaining exploitative and dominating international relations)
Paper 5	Highlights care and integrity as virtues of resilience	Notes potential for care as a way of 'domesticating' uncertainty (citing Groves 2014)	Interdependence is at the heart of care, solidarity at the heart of recognition, and reconciliation at the heart of solidarity.

Dealing with difference

The risk-management approach to climate impacts (a direct expression of the dominant social imaginary as described by Groves, 2014) is typically entirely ahistoric and unsituated, a product of technocratic analysis using models and geographic information systems at a fairly crude resolution. Even in the more developed forms used in adaptation analysis by the IPCC,

its consideration of differential population vulnerability is limited, while so far, SRM modeling has entirely failed to consider differentiated vulnerability to its likely distributed effects (*Paper 2*). This is, of course a form of mis-recognition of the affected vulnerable populations.

In *Paper 2* I further suggest that recognition of differentiated vulnerability should also include recognition of the ways in which uncertainty itself has differentiated impacts. Populations with strong capabilities can mitigate for uncertainty through mobility, insurance, inherited wealth, institutions and resources, by building reserves and savings, and so forth. Populations with weak capabilities have fewer options, and thus are harmed (at least psychologically, if not materially) by a level of uncertainty that might seem innocuous or even stimulating in a rich community. In these ways uncertainty and indeterminacy are multipliers of vulnerability.[13]

Alongside an unsophisticated approach to vulnerability, in another emanation of the dominant social imaginary, the modeling reviewed in *Paper 2* (with a few exceptions) also presupposes uniform preferences within and across societies (Heyen et al 2015), thus failing to recognize differences based in divergent values and preferences. Such an analysis points at a pervasive misrecognition of affected populations (now and in the future) insofar as neither their specific and differentiated vulnerability, nor their specific cultural values and preferences are recognized by the modelers and their tools (climate impacts assessment does a better, if still imperfect job, with secondary analysis of vulnerability). A better understanding of the inherent indeterminacy of CGE (see Section 2.4) (and indeed of ethical stances with respect to it – see section 1.1) however indicates that our response to uncertainty cannot just be to do better modeling, with more factors, and more detail so as to refine the analysis of risks, and subsequently tailor climate interventions to 'manage' those risks. Even though such technical improvements in modeling continue to be made, it is more important, and more urgent to examine ways to open up the imaginaries, methodologies and epistemologies involved, and to build resilience in the face of indeterminacy. *Paper 5* emphasizes care and integrity as virtues of resilience. This is not to position vulnerability as a moral rather than political concept. Following Ferrarese (2016a&b) I see vulnerability as both moral and political. A capabilities approach implies a

[13] However, public fear of the impacts of CGE might also be exaggerated by uncertainty, in the way that the risk of other unfamiliar and unpredictable harms such as terrorist incidents appears to be overestimated in comparison to the statistical average, while risks of the mundane, such as road accidents, are in contrast underestimated.

political response to vulnerability, with collective political institutions underpinning capabilities for the otherwise precarious and excluded. Vulnerability is not just about technical functions of susceptibility and exposure, but rather about relative power, both to do violence, and to oppress in other ways.

Paper 5 also highlights care as a way of 'domesticating' uncertainty (following Groves (2014) in his idea that we must live alongside uncertainty, while not entirely managing or controlling it). Arguably such uncertainty is endemic and unavoidable. It clearly appears in the public responses to CGE noted in *Paper 3*. Moreover, the discourses reported in *Paper 4* can be seen as diverse engagements with uncertain futures, which in turn co-create those futures. The ways in which today's actions co-create futures are nowhere more entangled than in the ways in which they determine the existence and identities of future people. As the non-identity principle (Parfit 1983) suggests, it is difficult to attribute responsibility for, or even to talk meaningfully of personal harms done to future people whose existence and identity depend at least partly on the very act that appears to do that harm. Groves (2014) argues convincingly that Parfit's analysis is part of the dominant social imaginary, and its view of rational choosing individuals, whereas in a care-based imaginary the motivation and duty of current people to care for the future becomes clear. But the non-identity problem highlights starkly the vulnerability of future generations to the present. Not only can present people (or those of us with agency and power) determine the conditions in which future people will have to live, but we can affect their very identities and existence. In this the non-identity problem echoes McNay's (2008) concerns about recognition – insofar as a liberal approach to recognition tends not to acknowledge the ways in which powerful interests shape the very identities of the oppressed or subaltern. It also echoes the challenges documented by Bellamy and Lezaun (2015), and Chilvers and Kearnes (2016) regarding the ways in which publics can be constructed by engagement and participation, where the process constructs identities in line with particular social imaginaries and thus potentially re-constructing and sustaining particular social injustices.

Problematizing identity

All these problems demand a more sophisticated and problematized approach to identity in justice theory. It is inadequate simply to suggest that we can't judge what's just when identity is fluid (or indeterminate), or to abandon demands for justice based on expressions of identity. I argue in Section 5.4 for a political approach to recognition which problematizes identity, and underpins restorative justice for historic harms. To illustrate the scope here, consider slavery (Kumar 2009, Shiffrin 2009). An advocate of the non-identity position might

argue that slave owners could not be held meaningfully accountable for the impacts of slavery on the descendants of slaves who would not even have existed (with those identities) but for the practice of slavery, and perhaps by extension that those inheriting the benefits of slavery should not be held responsible for the relative disadvantage of those descendants of slaves. But an argument from a recognition perspective means taking account of the impact of the effects of slavery on those identities, implying that not only could such impacts be foreseen, but that there was a moral duty to avoid them (as part of the broader moral duty to desist from slavery). With the benefit of hindsight, the injustice becomes clear (including the injustice done by those inheriting the benefits of slavery who refuse to recognize and make restitution for that). Furthermore this example makes clear that the non-identity problem embodies a temporal bias (another result of its foundations and presuppositions arising in the dominant social imaginary and its view of time) in contrast, for example to the cyclical views of time in some indigenous imaginaries (Winter 2017)). I argue that from a recognitional perspective, we should attempt to see things from the perspective of the affected group, not ours – including their position in time.

A politics and ethics based in recognition, capabilities and care as a response to vulnerability, and one which problematizes identity, and supports restorative justice, would therefore appear central to the development of resilience and solidarity in the face of inherent uncertainty and indeterminacy.

Solidarity and interdependence

Yet solidarity is not just an issue of a moral impulse that triggers restitution from those with power and influence in the modern world. It is, I argue in Chapter 5, an inevitable product of material and psychological interdependence (which exists not only between rich and poor in today's world, but between generations (see Section 5.3)) and of the potential for transformative political inclusion that such solidarity makes possible. As indicated in *Paper 1*, and as Hourdequin (2012) has also argued, CGE (especially in SRM forms) appears to disrupt the hard-won understanding of interdependence and solidarity that helped initiate mitigation efforts. Although it can be argued that SRM research at least could be seen as an obligation to the global poor (Horton and Keith 2016), policy-making and governance does not exhibit the same degree of interdependence (even if one were to countenance the prospect of counter-geoengineering as a means to force negotiation (Morton 2015, Parker and Keith 2015)). Moreover, such an argument implies a global social manager (a key fiction of the dominant social imaginary), rather than the stark asymmetries in power and interests that mark global politics. It may be true that there are common instrumental interests in

deploying SRM to prevent excessive temperature rise, but also starkly diverging interests in what that might imply for mitigation policy (*Paper 1*), and for the details of any given deployment (Heyen et al 2015). In deliberative circumstances, publics recognize the threat of vested interests, but seek responses rooted in solidarity and global agreement (*Paper 3*). Yet the dominant discourses of CGE (*Paper 4*) tend rather to sustain international disputes arising from exploitative and dominating international relations.

By contrast a care-based social imaginary would recognize interdependence, as suggested by Held (2006) in her efforts to extend the ethics of care to international arenas. With recognition of the globally subaltern comes the possibility of solidarity through full inclusion and participation in a global polity. And with solidarity comes the prospect of repair, restorative justice and reconciliation (*Paper 5*).

This section has further explored weaknesses of the risk-management approaches of the dominant social imaginary. It has emphasized the ways in which this downplays differentiated vulnerability, and a politics of recognition which provides a basis both for care for the future and for restorative justice with respect to the past and present. I return to the politics of recognition in the closing chapter of this document. Next, however, I seek to synthesize the lessons so far and complete making the case for a plural conception of justice, rooted in a transformed social imaginary.

4.5 Reconfiguring justice in climate geoengineering

In this chapter I have so far described how consideration of CGE discourages adequate mitigation, as an emergent socio-technical effect exacerbated where power is asymmetric. I have emphasized that such mitigation deterrence would be a serious justice concern insofar as mitigation brings justice benefits that CGE does not, or promotes transformation of unjust economic and political systems that are otherwise sustained in the face of climate change by CGE. I have argued that that sustaining effect partly arises from the depoliticized nature of dominant CGE discourses, which also frame out many aspects of justice, especially on the recognitional and restorative dimensions. This analysis argues instead for a politics of recognition to provide a basis both for care for the future and for restorative justice with respect to the past and present.

Here I revisit and summarize reasons why conventional approaches to distributional and procedural justice fall short when faced with challenges such as climate change and CGE, and complete the case for a plural approach also involving recognitional and restorative justice (the latter rooted in concepts of capacity and complicity). In particular, I argue that

seeking such an extension requires a transformation of the dominant social imaginary, which in turn demands a cultural and moral understanding of recognition and repair.

The shortcomings of liberal justice principles

The distributional and procedural principles of modern liberal approaches to justice (rooted in modern administrative social imaginaries) are inadequate to evaluate CGE, even in their own terms, and much less so if restorative and recognitional dimensions are also to be considered.

A strong (albeit limited) liberal distributional case can be made for both CDR and SRM forms of CGE, as described in Chapter 1. Those arguments either assume that mitigation and adaptation alone cannot deliver climate safety; or presume that the rates of mitigation necessary to achieve that could only be delivered by economic deceleration or degrowth. Such a strategy would be highly politically challenging and could be expected to impose greater stresses on the currently poor, at least unless it were managed deliberately in ways intended to deliver justice. So in this form the argument is that CGE is a lesser evil (Gardiner 2010) as a means to reduce inter- and intra-generational injustice arising from climate change. But the distributional effects of CGE are more complex, and (on balance less positive) than these arguments suggest. From the likelihood of novel climates predicted to arise from SAI (*Paper 2*), to the demands for land, energy or minerals to run CDR (McLaren 2012a), there would be significant distributed consequences. Assessment of these tends to ignore or underplay distributed vulnerability. Moreover justice also demands that we consider also whether the distribution of indirect benefits is fair: including issues such as who profits from the development of these technologies and the capacity they offer to suppress the effects of continued fossil fuel extraction and use. In practice, the distributional consequences of any given CGE scheme will depend on details of design, motivations and interactions with vulnerabilities, potentially as much as it would on global effects. And we can't simply assume either the technical capacity, or political motivation, to design (monitor, and control) deployment in ways that would be pro-justice.

On procedural justice, CGE researchers more often acknowledge a need for fairer – particularly more broadly inclusive - procedure, typically in discussion of the importance of governance, and the significance of public consultation or even deliberation (SRMGI undated). On the other hand there remains a significant current in political commentary that positions CGE as a technical, administrative solution, which simply needs to be better explained to the public, and which might, in SAI forms, be able simply to sidestep

requirements for international agreement, or in CDR forms, be embedded in technocratic carbon markets (*Paper 4*). This implies an administrative approach to procedural justice rather than a broad political one which engages directly with questions of power and agency. Examples such as genetically modified crops and nanotechnology (Pidgeon and Rogers-Hayden 2007, Wynne 2016) have illustrated how such procedures tend to constrain the issues and participants treated as legitimate.

Moreover, as McLaren (2012b, and McLaren, Krieger and Bickerstaff 2013) show (using the example of CCS), existing provisions for procedural justice in most polities are inadequate to address the extended chains of effect and widely distributed stakeholder interests across which injustices might arise with technologies such as CGE. While we might wisely endorse principles of transparency, participation and access to justice for CGE (as the Århus convention suggests for 'environmental matters (McLaren 2012b)), and also public funding and independent oversight for research (Rayner et al 2013), as ways to improve procedural justice, we still need to beware the way in which public engagement over emerging technologies can itself construct or constitute a public in ways that reflect the dominant framings (Bellamy and Lezaun 2015). Moreover the dominant social imaginary links such liberal justice principles with economic freedoms, yet those same economic freedoms not only underpin the failure so far to respond to the crisis of climate change, but also appear - whether acknowledged (Lane 2013, Davies 2013), or unacknowledged (Reynolds 2014) - to motivate advocacy for CGE research or development. Notably, discourses of liberal freedoms of choice and human rights tend to contribute to growth in climate emissions, for example by justifying car-use in preference to public transport (Kotze 2014) as much, or more than they have enabled collective or legal action to constrain them.

Human rights are the center-piece of liberal procedural justice. But rights-based approaches can be critiqued as individualist, liberal, paternalist, anthropocentric, ahistoric and culturally narrow, amongst other shortcomings. They downplay difference: different needs, different histories, different identities, different cultures and different interests. The associated impartiality of 'blind justice', rooted in the liberal social imaginary, prevents a focus on material and cultural difference and on historic injustices that demand restorative responses. Rights discourses assuage the guilt of the complicit, without offering genuine equality for the victims of slavery, colonialism and genocide (Meister 2011). And, as Fraser (in Fraser and Honneth 2003) contends, justice activism focused on accessing existing rights may never get around to contesting the terms of the social contract *per se*. More generally, modern rights-based approaches help constitute a particular form of political subject: the

individual, rational, choosing, consumer agent (notably with civil rights and consumer protections, rather than economic and social rights). In this context, rights that constitute everyone as the same liberal, rational consumers are little better than no rights at all – they do not grant meaningful agency.

The significance of such critique becomes clearer from a perspective of recognition. In this light, the liberal rights-based approach constitutes mal-recognition, in that the ways in which identities are constructed themselves serve to normalize particular forms of oppression or disadvantage. Other approaches to CGE in the dominant social imaginary also mis- or mal-recognize those affected by it. For example, pathways modeling that simply assumes huge areas of biomass production for BECCS, or climate modeling of SAI that – in its co-construction of technological imaginaries, and consequentialist conceptions of justice - presumes common interests and values across affected populations (helping constitute a single Anthropocene humanity), overlooks structural oppression, variegated vulnerabilities (and the historic injustices that underlie these) *(Paper 2).* The result is the construction of political subjectivities that reserve agency to technocratic experts, interventions that assuage guilt rather than providing restitution, and devalue local knowledge and lived experience.

Yet many liberal conceptions of justice do not explicitly consider recognition. Typically, it is merely presupposed in universal membership of the moral community. But the thin conceptions of such liberal citizens allow all sorts of mis- and mal- recognition to continue: formal recognition as a human is of little value to a disabled person treated equally with an able-bodied one, or a trans person treated as if cisgendered. Formal recognition remains of limited benefit if structural or cultural discrimination continues to impose harms, stress or uncertainty on particular groups. Effective, actionable civil rights are one tool for practically implementing or defending recognition, but there is still a potential justice shortfall if the model of rights defended does not have space for different cultural values, epistemologies and even ontologies. Models of rights that see them as 'something to be granted' rather than defined in struggle ensure that rights take forms, and reflect conditions, defined by the imperial metropole, administrative imaginary and liberal paradigm, rather than forms reflecting the imaginaries of oppressed communities.

Genuine recognition underpins the possibility of restorative justice for those harmed by climate change and the nexus of inequalities around fossil fuel extraction and use. A focus on restorative justice demands a much more sophisticated approach to assessing the impacts of climate change and geoengineering on diverse communities around the world,

and argues in favor of a care and repair strategy that focuses on the conditions of those disadvantaged by the fossil economy (Malm 2016) and climate change. Restorative justice can be understood as constituting actions that correct for previous failures of recognition, participation or distribution. It emphasizes justice as 'fairness' rather than justice as 'equality', not in a directly Rawlsian sense, but in the sense that it responds to difference rather than assuming universality (Young 1990). It acknowledges that equal treatment of unequals is inevitably unfair, and consistently biased towards the already dominant and advantaged. It is unjust to overlook the past history of oppression and inequality if we are trying to identify fair treatment today. In other words the only way to establish a 'clean sheet' is to seek restitution or at least forgiveness for past harms. It cannot be simply assumed as all too often occurs in CGE discourses (*Paper 4*).

So a just solution to climate change implies not just a 'fair distribution' of costs and benefits of climate policy over space and time, but a redistribution of power with proper procedural accountability of decision makers (and beneficiaries) to the victims of anthropogenic climate change, and restorative justice in the form of reparations or compensation; alongside recognition and participation for all those affected. To place this in real world rather than the transcendental world of ideal moral philosophy requires engaging with questions of power, politics, agency and the ways in which they are shaped and constrained in collective discourses, narratives and imaginaries.

Reconfiguring the dominant social imaginary

This is not to say that CGE should simply be rejected, but that the forms it takes today, shaped by the dominant social imaginary need to be reconsidered and evaluated against a broad set of grounds for justice. Climate change is a product of, and cause of, historic and ongoing injustices. A restorative approach to climate justice might include compatible expressions of CGE. Insofar as we accept grounds to act on justice issues arising from culpability, complicity and capacity (as introduced in Section 2.6) these would seem to demand that engagement with CGE, as well as with other responses to climate change.

By capacity here I mean that ethical duties can arise directly from our capacity to act to prevent or mitigate harm or injustice. Climate change is already causing widespread harm and injustice, and the problems are set to get worse. Justice demands that those with the knowledge, power and resources to act should do so – to avert dangerous climate change or to restore a more hospitable climate. Capacity is my interpretation of a duty of care (Held 2006), which arises not from culpability but from the simple basis that care is needed, and

those capable of providing it (directly or politically, through caring institutions) are ultimately the only ones who can provide it. The default must be an expectation to care, rather than accepting a culture of uncare (Weintrobe 2014). Complicity means that ability to act is reinforced by arguments from responsibility: not just those directly culpable, but also all of us who have benefited materially from the actions that have caused climate change (above some basic level of need) (Baer et al 2008, O'Neill 2010, Shue 1993) – even if we did not undertake all those actions personally - bear duties to act (as far as our individual and collective capabilities stretch). Complicity forms a solid foundation for restorative justice – based on the understanding that those who have benefited from climate change should deliver restitution to those harmed by it.

What actions should be taken as a result of this analysis? I do not argue that these grounds of justice justify deployment of CGE within the modern social imaginary, but rather constitute reasons to seek to reconfigure that imaginary, and in turn reconfigure the socio-technical emanations of CGE. It is widely accepted in ethics that negative duties - to withhold from doing harm – form justifiable limitations on freedoms, even within the dominant social paradigm. Whether this extends to duties to mitigate, actively cutting excessive consumption of fossil fuels, is relatively uncontentious (Gardiner 2011a, Jamieson 2010). Climate change ethicists rather debate what factors might limit this responsibility. Positive duties to 'do good' are, oddly, more difficult to justify within the dominant social paradigm: these are often seen as voluntary or charitable. I argue that they can be justified by responsibility or complicity. In such cases they might be seen as compulsory, such as the forms of restorative justice which demand criminals apologize to their victims or undertake community service. But such an interpretation is far from universal in the dominant social imaginary. On the other hand in a care-based social imaginary such restorative duties not only gain more prominence but would appear essential to justice.

A care-based imaginary brings virtue ethics to the fore, as opposed to the consequentialist or deontological approaches that characterize post-enlightenment thinking and the modern social imaginary. A virtue approach to climate restoration would emphasize humility – focusing on re-establishing conditions in which the system can rebalance and heal itself (absent excessive anthropogenic forcings). In practice this suggests an ethical preference for mitigation and carbon dioxide removal over adaptation or SRM, but does not categorically exclude CGE.

To consider whether any form of CGE can be seen as restoration, I need to unpack ideas of 'restoration and repair' a little. Ideas of 'climate repair' or 'climate restoration' are complex.

Besides the framing effects of implied control and capacity, there are ethical distinctions between repairing an artifact, such as a building, and restoring a natural system, such as a human body or an ecosystem (see *Paper 5*). In the latter, practitioners and theorists recognize human inability to return the system to a prior state, still less to restore it to some 'original design', and instead seek to establish conditions in which the system can re-establish (relative) autonomy (or integrity) and health for itself. And even in the former case practitioners recognize that seeking the 'perfect restoration' of a historic artefact is equally a misleading and inappropriate goal: instead understanding (as Richard Sennett (2013) highlights) that changing materials and purposes imply a process of reconfiguration, and thus demanding transparency (or legibility) in repair work. For instance the Japanese art of Kintsugi involves repairing broken pottery with golden cement or lacquer which highlights the experience of breakage and repair. This makes a virtue of repair, makes the process legible, and leaves a durable reminder of the fragility of the subject.

CGE in current forms focuses on restoration as a physical, technical issue, focused on a visible and functional fidelity to the previous climate, rather than as a moral or cultural issue focused on ethics of care, integrity and legibility (*Paper 5*). Or, put another way, as an environmental, rather than a social issue. Once again, the echoes of the consequentialist dominant social imaginary are clear. Some forms of CGE – especially CDR ones such as soil or ecosystem restoration - hint at a broader restorative or caring virtue (Martindale 2015, Buck 2012b, Olson 2012) and might help co-produce the shift in social imaginary that is most needed. Others, notably SAI, seem likely to sustain the dominant social imaginary instead, making restorative justice less likely. SRM broadly reconfigures, not restores. Moreover, SRM technologies, with their relative low cost and high leverage, would appear particularly vulnerable to deployment as a means by which the rich world can avoid fulfilling its duties to correct for historic climate injustice. CDR on the other hand might offer a remedial tool, but only if responsibility to bear its costs were fairly distributed (for example, divided on the basis of historic cumulative emissions), and further compensation were provided to address any distributed inequalities arising from its deployment. But the dominant framings of CGE – both SRM and CDR (*Paper 4*) reveal technologies mobilized to repair not the environment or climate, but capitalism, acting to help mask the damages of industrial capitalism, providing new 'invisible' forms of maintenance and repair to supplement those on which capitalism already relies, but rarely reveals, and consistently devalues in terms of the misrecognition of those who sustain, or suffer the burdens of repair (from women's reproductive work, to

those involved in recycling of hazardous products and wastes) (Jackson 2014, Russell and Vinsel 2016).

Towards a just climate restoration

Arguably the thing most in need of restoration or reconfiguration is not even the climate itself, but humanity's relationship with our environment (Hulme 2009). The modern managerial social imaginary enables and legitimates an exploitative, instrumental relationship with the Earth. It does not respect the Earth or Earth systems as in any way independent moral agents with their own interests and integrity. Yet lessons from other disciplines of repair (summarized in *Paper 5*) suggest that an ethical approach to repair treats the subject in those ways (as a 'subject' rather than an 'object'). It could be suggested that to establish the conditions in which a healthy relationship can flourish humanity needs to lose its technocratic hubris and be reconciled with the Earth.

'Just climate restoration' might imply, in an ideal form, therefore seeking to reset conditions in which systems can heal themselves; as a form of reconciliation (with the earth and its people), offered as reparations for past injustices; with new humility. An instrumentalist and consequentialist approach to climate repair in the Anthropocene by contrast risks exacerbating the problems of the discourse: enhancing authoritarian approaches; widening power disparities; and inflating hubris, while suppressing or constraining the deliberation, dissent, practical reasoning and experimentation in which new ethical responses could emerge. It is not only that talking of CGE as simply objective and scientific, and with limited reference to ethics and justice is potentially misleading, but that it blinkers or constrains the human capacity to imagine, and to construct in emergent practice, appropriate ethics or virtues for the Anthropocene.

Nonetheless, in practice such an approach might enable greater deployment of CGE, and in turn this might reduce objective climate risk more – or at least more rapidly – than a just restoration approach, in ways that directly and materially benefit those most vulnerable to climate change. Yet the technological imaginaries embodied in most CGE (and especially SRM) proposals reproduce a set of social imaginaries that are instrumental, individualist, managerial, competitive and exclusionary, and thus not coherent with strategies to enhance justice more generally, leaving the exploitative international relations, and deep inequalities of neo-liberal austerity capitalism in place. Efforts to deliver climate justice with SRM in particular seem likely to be counter-productive; whereas the social imaginaries co-produced with a reconciliation framing of climate restoration (likely expressed in terms of mitigation

and adaptation, reconciliation and compensation for historic injustice), and some elements of CDR – particularly ecosystem and soil restoration - would seem coherent with further interventions to minimize the social impacts of side-effects, such as the economic impacts that might arise from extremely rapid decarbonization.

The final chapter of this thesis turns in more detail to the question of recognition and how it might be mobilized to transform political subjectivity and the dominant social imaginary.

Chapter 5: Justice as recognition: a radical political account

Chapter 4 concluded with a vision for a reconfigured social imaginary, in which restorative justice comes to the fore. But the means by which such a transformation could be delivered remained unclear. Here I argue that a political approach to recognition offers the foundation for transforming political subjectivity in ways that make such a reconfiguration of the social imaginary possible. This chapter therefore outlines a new synthesis of approaches to justice as recognition. It seeks to develop the account applied in environmental justice scholarship, simultaneously further politicizing it, and re-grounding it in a care-based social imaginary. It argues for a broad and relatively abstract model of recognition, applicable not only internationally, but also inter-generationally. It emphasizes the critical role of recognition in restorative justice, and its potential to transform the dominant social imaginary, concluding with some reflections on this interpretation of recognition for climate justice and CGE.

5.1 Significance of recognition understood broadly

So far in this thesis I have identified at least six different ways in which issues of recognition arise in considering the justice of CGE. First there is a lack of recognition of difference in CGE discourses and literatures (including diverse forms and degrees of vulnerability and different preferences). Second, forms of knowledge and ways of knowing outside conventional empirical science are largely unrecognized. Third, future people are mis-recognized in the dominant liberal social imaginary. Fourth, current people are mis-recognized in deliberative procedures which unreflexively construct new publics. Fifth, the present effects of past injustice, including colonialism, industrialization and fossil fuel exploitation are also typically unrecognized. Sixth, there are a series of ways in which all these forms of non- mis -and mal-recognition deny meaningful agency to those affected.

The approach to recognition implied and applied here includes but also extends beyond the mainstream (liberal) interpretation. Scholars of recognition often hint that it offers something beyond the liberal paradigm (e.g. Fraser and Honneth, 2003, Hourdequin 2016), but largely remain rooted in that paradigm, especially in their focus on human rights. Within the liberal paradigm, recognition would demand that we recognize the various groups – such as indigenous peoples, women or future generations - that are vulnerable to climate and geoengineering impacts, and the ways in which institutions and systems may impede their full participation through misrecognition. I argue that an understanding of justice as recognition must also engage with the procedural and substantive terms on which inclusion

is achieved. In particular, as a normative concept for societies, recognition (following Schlosberg 2007) advocates treatment of all persons[14] as moral equals, recognized and valued for difference, not despite it. Demands for recognition of difference, such as those in the Black Lives Matter campaigns, are not primarily a call for equality and inclusion in the existing social and political order, but campaigns for reconfiguration of that order in ways that recognize and respect cultural diversity, difference and history. Like recognition demands from indigenous communities, they are not calling for integration, but for respect (Connell 2007). Nor are such demands rooted in essentialized ideals of cultural identity (as implied in McNay's critique of recognition (2008)) but rather involve rejection of the identities imposed by structural and cultural oppression and discrimination, and thus constitute demands for the opportunity and agency for groups and collectivities to reconstruct and reconfigure their own identities. Recognition asks social institutions and other individuals to acknowledge – and value or reject as appropriate - diverse aspects of individual or group identities where they are significant to those people as a part of their self-identity, confidence or agency, or as a source of economic, cultural or other disadvantage. Thus – for example - to respond to racial oppression with a stance of 'color-blindness' is as much a failure of recognition as is active discrimination on racial grounds.

Such demands reflect broad understanding of the harm of non-recognition, or of mis-recognition therefore as not only the social status injury arising from exclusion from society (Fraser in Fraser and Honneth 2003) but also the psychological harm arising to the personal identity from such rejection or exclusion (Honneth in Fraser and Honneth 2003). Even though our identities are much more fluid and complex than many commentators on psychological recognition appear to acknowledge, almost everyone feels harm when their self-image is damaged. Similarly, almost everyone seeks confirmation of their value as a person in interpersonal relations of love and respect that recognizes one as "unique and valuable" (Steinbeck cited in Popova, 2012). Yet philosophy, psychiatry, literature, and religion alike highlight the psychological dangers of too great a focus on the self, arguing rather for a balanced approach to identity which not only places the individuated self in a network of affective social relationships, but which also incorporates a sense of perspective

[14] Agent, or actor might be a better term than person here, especially in the environmental domain, where the agency and moral standing of non-human species and ecological systems is a matter for debate. However this debate is beyond the scope of this thesis. And where the process of recognition is in part the establishment of subjectivity for those whose agency is lacking or constrained, to use the term agent might be confusing.

of the self in relation to the world. Cain (2016) describes the latter as understanding 'the spectacular indifference the world has towards [one's] personal needs'. It is perhaps the reality of indifference from the (non-human) world that makes it so important to us (as needy embodied humans (Sayer 2011)) to experience recognition from our peers. Recognition as justice therefore implies mutual inter-personal recognition. In this context the diversion of our individual regard from ourselves to our peers (in granting recognition) becomes central to a practice of living in the social world (in contrast to the administrative social imaginary of rational selfish individuals).

Thompson (2013) also argues for a synthesis of the perspectives of Fraser and Honneth. He suggests that if recognition is at core an inter-personal psychological process (as suggested by Honneth), this does not preclude it being considered also in terms of status equality and participatory parity (as argued by Fraser). I concur with Thompson in seeing both social and psychological aspects to recognition, but also wish to problematize further identity and self-realization. Thompson interprets Honneth's approach as an argument that "If suitable relations of care, the right sort of system of rights [providing respect], and an appropriate value-horizon [providing esteem] are all in place, individuals may form integrated identities and hence be able to achieve self-realization" (2013:92), thus achieving full recognition and avoiding psychological harm. Delivering self-realization in practice is perhaps even more complex than this implies, once we take a narrative approach to identity in a non-ideal world, and - in line with McNay's critique (2008) - recognize the capacity of structures and discourses to internalize oppression and discrimination in identities, behaviors and beliefs. This does not undermine the normative value of achieving recognition, but merely emphasizes the difficulty; and the necessity for measures to ensure the status, resources and voice necessary for citizens to be able to enjoy parity of participation; and in turn therefore to achieve care, respect and esteem enabling them to build mutually the capacities to repair or reconfigure their identities in ways that reflect the goals of justice as recognition.

Neither Thompson nor I, therefore, claim (as Honneth does) that recognition is the irreducible universal of justice, rather, that it is more than just 'another dimension of justice' (as Fraser portrays it). Recognition as I have described it here is a *necessary precondition* for distributional, procedural and corrective/restorative justice. Moreover, in an understanding of justice as contested, discursive and co-produced, recognition of different groups and interests is a key mechanism enabling the social (re)construction of collectively applied conceptions of justice. But while recognition can be seen as practically prior to voice

(procedure) and fairness (distribution) it is not determinative of them, merely a necessary condition without which struggles for participation and equality will always fail (although it might be co-produced in such struggles in an embodied form as Velicu and Kaika (2015) suggest).

The significance of recognition to other forms of justice implies that international and intergenerational justice also require a functioning account of recognition. Moreover we need to recognize that the exercise of economic and cultural power on the distributional dimension also structures and underlies misrecognition (including through the constitution of accepted subaltern identities) (McNay 2008, Dübgen 2012, Fraser in Fraser and Honneth 2003). Corrective justice too requires recognition both in terms of constituting subjects who can expect restitution, and in terms of understanding the nature of culturally appropriate remediation for harms. The relationship between restorative justice and recognition – where many of the factors in contemporary inequality have their roots in historical injustices such as slavery and colonialism – further emphasizes the need for an account of recognition that is intergenerational too. But before considering what that might look like, I need to unpack further the different circumstances that fall short of full recognition, and consider whether these are fully considered in existing accounts.

5.2 Limited forms of recognition

In the previous section I argued that recognition has broad relevance for justice, and that its absence causes both social and psychological harms. But it is important to note that recognition and non-recognition do not constitute a simple binary state. There are several forms of partial or inaccurate recognition, as well as complete non-recognition. Where members of a certain group are completely excluded from the moral community, that is non-recognition. Non-recognition constitutes its victims as invisible, unheard, even as 'non-persons'. It legitimates instrumental treatment of members of that group (e.g. of animals; previously of indigenous peoples and slaves; today in some places of migrants or refugees). For humans, forms of partial or inaccurate recognition - which can be described as mal- or mis-recognition - are now more common. For instance, Connell (2007) outlines the ways in which colonial metropolitan science constructed a *homo primitivus* of indigenous populations, legitimating their decimation and the usurping of their lands and resources. Today's scientists and economists mis-recognize non-western peoples rather as *homo economicus*, but the result is still a complete failure to acknowledge the significance of difference.

I treat mal-recognition as including situations where despite some form of inclusion, unequal rights persist (such as rights under the law, but no right to vote), and situations where formal recognition has been granted (full equal rights), yet in practice cultural or structural discrimination continues, leading to status injury (Fraser in Fraser and Honneth 2003). Mal-recognition also includes circumstances in which identities are constructed or restructured in ways that reflect and accommodate injustice, such as where the imposition of cultural values or practices (or a habitus) leads to members of subaltern groups accommodating to oppression (e.g. women who identify as home-makers); Mis-recognition arises where groups are included in the moral community of humans merely as 'humans' (an extremely 'thin' form of recognition), yet specifics of their culture or identities are ignored – for example treating trans people as if they were cisgendered, or people with disabilities as if they were able-bodied. More subtle forms of mis-recognition include failures to recognize changes in identity over time (such as those brought about by changing family status, or large scale political changes such as the rise and fall of the Soviet Union); and failures to recognize the impacts of inherited or otherwise structured inequalities on the identities of those affected (such as the effects of poverty on children's development (see for example Luby et al 2013) or of hormone disrupting pollutants on future generations (Colborn et al 1996)). In other words it is as much misrecognition to treat superficial 'objective' identities resulting from situated injustice as an essential and unchanging basis for recognition and treatment as it is to ignore those aspects of difference and different needs and values that arise from biological or cultural factors such as sexuality or ethnicity.

Within the liberal paradigm of justice and the administrative social imaginary, ideas of recognition often seem somewhat constrained – either presented as if participation in society on the existing terms defined by those already included would be adequate (Hourdequin 2016, Phillips 2003, Thompson 2013), or criticized as if they could only be interpreted as suggesting such a limited form of participation (McNay 2008, Velicu and Kaika 2015). Mis-recognition in the forms I consider here is often overlooked, or at least not adequately problematized in moral philosophy, political theory and environmental justice (Taylor 1992, Hourdequin 2016, Phillips 2003, Thompson 2013). Recognition is typically portrayed in thin ways as a partner to rights and procedural justice, implying cultural assimilation of the newly recognized, rather than a means by which such procedures might be enriched or reconfigured in ways that offer intercultural respect.

For example, Hourdequin adopts Whyte's (2012) largely procedural definition: "recognition justice requires that policies and programs must meet the *standard of fairly considering and*

representing the cultures, values and situations of all affected parties" (2016:35: emphasis added). Phillips (2003) sees struggles for recognition as demands for political voice, dependent on group recognition. She helpfully emphasizes the collective aspect of this – that voice means being able to express and obtain action on collective interests of the group - but her analysis remains primarily procedural. Consideration of political voice does however permit us to distinguish recognition from simple physical participation: being included (or represented) in a process does not necessarily avoid mis-recognition. The capacity of any given individual to express their needs and interests in a participatory process cannot be taken as a given. For example in deliberative processes, as noted in *Paper 3* (and highlighted by Burgess et al (2007)), all female groups are better able to articulate certain concerns than are gender mixed groups.

Thompson seeks to justify a rights-based approach to recognition. He recognizes that human rights form part of a paradigm rooted in cultural values, but, he suggests "by working toward the universal acceptance of those values, we should deny that this makes them [human rights] necessarily partial" (2013:102). I argue by contrast that the cultural values, and the rights they support might be reconfigured or transformed through genuine recognition of the currently unheard or unrecognized. In the work of Fraser (Fraser and Honneth 2003), Schlosberg (2007) and Whyte (2012), amongst others, while there are clear aspects of the liberal paradigms of the dominant social imaginary, there are also indications of much more radical possibilities for recognition as a challenge to that imaginary. For instance, for Schlosberg, recognition is a largely cultural concept, and lack of recognition means that other cultures' values and lifeways are not valued, and that such groups are unable to participate equally at the 'negotiating table' (2007:91). This clearly echoes Fraser's participatory parity, which does not presuppose any transformation of liberal institutions, merely inclusion within them. Schlosberg however also seeks an ecological reflexivity in institutions achieved through participation by different cultural groups and by representatives of environmental interests, in which diverse knowledges can trigger a 'more reconstructive moment' (2007:210).

Critics of recognition too tend to interpret recognition within narrow liberal paradigms and the administrative imaginary, which arguably makes the task of escaping those imaginaries much harder, undermines the possibility of recognition of the alternative values and knowledge systems implied by those critiques, and mis-recognizes the concepts of recognition themselves. The versions of recognition that are critiqued in the work of McNay (2008) and Velicu and Kaika (2015), for example, are in some ways extremely distorted,

paternalist models in which recognition is controlled and rationed by existing elites or power structures.

Velicu and Kaika's trenchant political critique of recognition highlights some very real concerns. But their description of recognition as a process that is purely directed at winning rights within the system; which does not challenge lack of voice or invisibility; and which is rooted in foundational identity politics with preconceived and hierarchically imposed ideas of identity is something of a strawman. Like McNay's broader concern that recognition advocates essentialize identity, even where it is a product of injustice, this is a reason for refining and politicizing our understanding of recognition, not for rejecting it. McNay's (2008) critique goes further still, arguing that it is impossible for recognition to overcome the powers of habitus to shape oppressed identities. Yet this conclusion effectively rejects the potential of agency, whereas McNay herself argues for a limited, but still real, critical agency, which therefore could mobilize a political form of recognition, regardless of the obstacles she carefully documents (such as the challenges of expressing such demands linguistically when language itself is shaped by oppressive habitus).

Other scholars have also laid helpful foundations for the task of politicizing recognition. Dübgen's (2012) critique of development aid as misrecognition (rooted in the managerial social imaginary) not only illustrates how redistribution without recognition is inadequate, but also offers helpful parallels for CGE as misrecognition. Dübgen draws on Frantz Fanon to describe the 'psychological violence' of dominance and subordination reproduced by misrecognition and epistemic injustice. She describes postcolonial misrecognition as a process in which former colonies are allowed to 'eat at the master's table', or in other words, join the global economy on neo-liberal conditions and principles (enforced with structural adjustment). Agency is reserved for the post-colonial powers, and decolonization represented as a gift, reinforcing an inferiority complex. Connell, citing Al-e Ahmad, analyzes the creation of subaltern identities in southern academics in similar terms: "Western intellectual domination sustains the inauthenticity of the subject in post-colonialism" (2007: 121). She further highlights the ways in which tribal and community identities were politically reconstructed in post-colonial states by processes such as the artificial delineation of tribal communities. Such analysis closely reflects McNay's interpretation of feminism: but with different conclusions for the possibility of agency for the subaltern communities. Dübgen and Connell see the exposure of these processes of misrecognition as empowering their victims to respond with political agency, while McNay (2008) seems to doubt such a prospect. Moreover - Connell suggests, citing Nandy - colonialism also reconstructs the

identities of the colonists, towards militarist, nationalist technocratic and patriarchal values. This insight that misrecognition also reshapes the oppressor's identity in harmful ways can perhaps be generalized: it certainly suggests an analogy with the CGE literature, in which some of the proponents of CGE appear to project a colonial hubris: as virile scientists guiding and nudging childlike or feminine publics and politicians towards climate progress.

Such an understanding of post-colonial center-periphery relations in terms of recognition suggests several further strong parallels with CGE: agency is reserved for the technocratic elite (the managers of aid projects and the high priests of climate modeling – or governments following their advice); the intervention offered becomes a way to assuage guilty consciences in the rich North (CGE rather than mitigation; aid rather than changing the terms of trade); and local knowledge - about how things work and are affected on the ground - is ignored or devalued (in a form of epistemic injustice). It also begs the question of whether recognition can be applied internationally, to which I now turn.

5.3 International and intergenerational recognition

Arguably, one reason recognition has not been a major consideration in discussions of justice in climate change and CGE so far is the significance of international and intergenerational concerns with respect to climate, and recognition theory has – for various reasons which I explore below – largely not engaged with international and intergenerational justice.

The principal argument against globalizing recognition is that recognition relies on direct inter-subjectivity, to a degree impossible between remote individuals. Thompson argues however that recognition can be applied to people at the global level, through "acknowledgement of the needs of all individuals, their capacity for autonomy, and their capacity to make a contribution to the good of the global community" with attention to "the sphere of global values, the redistribution of global resources, and the protection of universal rights" (2013: 101). This claim relies on his synthesis of recognition theories – outlined earlier - intermeshing principles of care, respect and esteem - drawn from Honneth - with the cultural, economic and political dimensions of justice emphasized by Fraser.

It suggests an abstract or generalized form of recognition of the other that is not embodied in a face-to-face intersubjective relationship, but is rather established through a cognitive imagination of empathy for the other. In this it resembles the globalized form of care relations described by Held (2006) as a means of applying the ethics of care internationally, with "attention to actual differences between persons and groups" and "resistance to

universalizing all into an abstraction of the ahistorical, rational-individual-as-such" (2006: 165). It also resembles Antadze's (2017) argument that Levinas challenges us to moral engagement even without physical encounter by putting an abstract 'face' on the unknown other to whom we owe ethical duties.

In these various ways it can be seen that an international application of recognition is entirely possible, although it may remain asymmetric insofar as it is dominated by the granting of recognition. But as Antadze adds, this does not imply any right to seek to make others like us, or to judge them by our values.

The situation in intergenerational terms is similar. Mainstream ways of thinking about future people constitute the sort of institutional or structural misrecognition that would be rightly condemned if the subject were women or people of color. For example, institutional use of economic discounting in considering public investments systematically devalues the costs and benefits accruing to future people in relation to those arising in the present, thus incentivizing a transfer of benefits from the future to the present, and of costs from present to future. Similarly treating the non-identity problem as a reason to ignore implications for future populations is equally a way of treating them as non-persons. Such treatment seems undoubtedly a status injury form of misrecognition as described by Fraser (In Fraser and Honneth 2003).

There are also challenges in applying recognition to future people. I briefly suggest three here, and suggest how they might be overcome. First, is that recognition is (at least partly) a response to a demand from a person or group not presently (properly) recognized or constituted.[15] Future people have no active way of placing such demands on us. Yet while, as I argue elsewhere, we must beware considering it only in such terms, recognition is also something granted. Second, is the dialogic nature of recognition. In contrast with many philosophical approaches to justice, recognition at its most powerful is practically dialogical – involving real encounters and deliberation with others. Our temporal distance from future people makes such dialogue impossible. But recognition remains possible and valuable over physical distance as we saw in the preceding chapter, and this offers an initial guide. Arguably some abstraction helps ensure that we do not, through recognition, essentialize

[15] The idea that an unrecognized group may not yet be constituted, insofar as it comes into being through the process of recognition, makes even recognition of present people more problematic than normally considered. In this respect recognition in the present is more similar to the case of future people. In either case the process of recognition creates the identity, and may do so in ways that are, or are not, caring and sensitive.

unjust forms of identity produced by oppressive habitus (McNay 2008). And a dynamic approach - which understands the production of identities, oppression and recognition over time in repeated interactions - also helps us avoid such traps. Third, others might argue that even if we could grant recognition to future people, the non-identity problem (Parfit 1983) means that their very identities (which are fundamental to any meaningful sense of recognition) are in part determined by our actions and decisions today. This is a powerful argument, but not decisive (Shiffrin 2009). It involves an understandable, but also unacceptable degree of temporal bias. From the point of view of future people, they would already exist in their embodied forms, and while they could not change our identities back in time, nor could they change their own. Their expectations of recognition would be unaffected by the philosophical expression of the non-identity problem (and may well resemble our expectations with respect to our predecessors – which can generate strong demands for recognition – such as calls for apologies or reparations for war crimes or colonialism).

There are three related ways in which we might apply recognition to future generations. First we might treat the problem as one of institutional misrecognition (following Fraser's approach to contemporary misrecognition) in a culture of uncare (Weintrobe 2014) or 'neglect' (Robinson, cited in Held, 2006). This would imply reforming and redesigning relevant institutions. But the participatory and deliberative mechanisms advocated by Fraser (in Fraser and Honneth 2003) and Schlosberg (2007) for contemporary recognition would not directly apply to future people. Weintrobe suggests instead that we need to develop empathy by imagining talking to potential victims "face-to-face and us looking them in the eye" (a psychological recognition of their moral status), and thereby generate an affective response to the problems (like climate change) that they face. Eckersley (2004) suggests that deliberation amongst contemporaries and across existing generations can help us learn about our inter-dependency and recognize and respect differently situated others including future generations.

Second, following Rahul Kumar, we might seek to apply a form of Scanlonian contractualism. Kumar (2009) suggests that, in contractualist terms we harm future people (regardless of their identity, or its dependence on our decisions) when we fail to give them the kind of deliberative consideration of their relevant interests to which they are entitled – where that entitlement is a general principle that no-one can reasonably reject (Kumar 2009:254). Such contractualism puts one "in a relation of mutual recognition with others" (Kumar 2009:265, citing Scanlon). It is interpersonal in this respect, but does not rely on cooperation or

reciprocity between generations, rather on an abstract criterion of 'justifiability of the conduct' to those who will live in the further future. Kumar draws helpful parallels with the descendants of slaves, who he argues, can legitimately feel resentment, and demand (at least) compensation in forms such as acknowledgement of the harms done to them, and (restorative) apologies from those complicit in inheriting the benefits of slavery.

Finally, we might draw on more communitarian concepts of intergenerational commitments and responsibilities rooted in our group identities and norms. In this understanding our care for the future is based on a desire to see group identities, collective projects, cultural traditions and norms preserved or maintained (Thompson 2009, Birnbacher 2009). Like Benedict Anderson's 'imagined communities of nationalism' (1983) we can thereby make future generations 'present in our minds' in ways that can influence our decisions and thinking. Relevant groups in this context are not just national, religious or ethnic – they might include, for example, scientific communities: the preservation of norms of science and the continuation of scientific progress could offer as strong reasons for future oriented commitments as the building of a nation. Samuel Scheffler (2013) takes the core of this argument out of an explicitly communitarian setting to argue that humans are all highly dependent on the continuation (and implicitly, flourishing) of future society (what he calls 'the afterlife') for many of the things we value to retain their meaning. Scheffler does not primarily offer his 'afterlife' conjecture as a foundation for intergenerational justice. Nonetheless, he concludes that it offers a case for 'greater motivation for the current generation to pursue the interests of future generations'. Because the current generation depends on future generations for our lives to have meaning this implies a form of reciprocity or interdependence: we are dependent on them for meaning, they on us for existence and the capacity to flourish. In other words each generation is vulnerable to the other in reciprocal but not symmetrical ways.[16]

Admittedly none of these fully escape the liberal paradigm and dominant social imaginary, but they offer a basic functioning intergenerational concept of recognition through a series of tools and methods that stimulate us to imagine and conceptualize some plausible interests of future generations in our care today. Combined with a more radical political account of recognition today, developed below, which opens the door to transformation of

[16] More radical approaches to cross-generational duties can be found in some indigenous cultures. Winter (2017) cites Aboriginal / Maori circular conceptions of time, which underpin an understanding that 'failure to pass on a better world to your descendants is to disrespect your ancestors'.

values and norms through recognition; this could become a useful tool for intergenerational justice in the climate sphere.

5.4 Politicizing recognition

In the previous discussion of limited forms of recognition I offered some gestures at what a political account of recognition might encompass: in particular, an understanding of a politics of difference as potentially transformative of norms, institutions and values. Here I explain further what a politics of recognition might mean.

Ingram (2006) seeks to begin such a task, taking us beyond psychological inclusion and contemporary identity politics of group voice and discrimination. He explores recognition as a means of establishing citizenship and subjectivity within an understanding of politics as a process through which a community creates and reconfigures norms, rules and institutions. He deploys resources from Rancière and Arendt to explore politics as freedom (see also section 2.2), within a diverse common realm, in which recognition enables the previously unheard to participate as equals in public affairs. Not only does such participation offer enhanced justice, it also stimulates the reconfiguration of norms and institutions. For Ingram, such citizenship gives us a stake in the world and the very point of political action is therefore to deliver greater inclusion and equality. Politics is therefore portrayed as a never ending contestation over the common in the name of a broader, more inclusive common: reposing questions of identity and justice, exposing the limits of the forms of justice accepted and institutionalized within the dominant social imaginary.

A political concept of recognition as justice clearly has to mean more than a paternalist granting of recognition by the dominant group, admitting a new minority into the moral or political community as long as they adopt the values of the majority. That would be mis-recognition. It therefore also implies demanding of recognition (by the unrecognized group and/or their representatives) – through agonistic resistance, conflict or struggle and, critically, subsequent dialogue between the groups so as to seek to understand and respect each other's values.[17] As Ingram argues, this constitutes politics as a process of never-ending enhanced inclusion. But such dialogue must be rooted in a mutual recognition of the value of inclusion; solidarity and 'living together'; otherwise it has no common foundation or even

[17] Connell's (2007) critique of metropolitan social science offers a striking parallel: that the discipline assumes a single universal form rooted in the metropole, which devalues and dismisses Southern theory, and even where it acknowledges the latter, it fails to enter into dialogue with it.

reason for taking place. This implies that there is no case to integrate the values of white supremacy, or homophobia, however culturally authentic such views might be in a group seeking recognition. Rather, there is a case to challenge the existing values of the majority where those seem to act to exclude, marginalize and mis-recognize (such as values of individualism and personal responsibility, for example, as opposed to care). Rather than demanding a broad commitment to liberal values, rights and duties as the foundation for moral inclusion (a paternalist, one-way process), this analysis rather suggests a single universal foundation of a commitment to mutual recognition or solidarity as the irreducible minimum, on which dialogic processes can be built, and the social imaginary redefined through the ongoing process of ever-broadening moral inclusion and reconfiguration of the political commons (Ingram 2006). Such a political reading of recognition as inclusion moreover offers a credible foundation for Martin Luther King's claim that the arc of history bends towards justice, insofar as the practical exercise of inclusion in this way is extremely hard to reverse (as Donald Trump is discovering, despite the power of the Presidency). In other words there is a cultural evolutionary tendency expressed in a 'moral ratchet' which locks in ever broader inclusion.

Furthermore, I argue that a political concept of recognition demands recognition of difference both as diverse attachments and identities, and as diverse vulnerabilities. It does not seek to eliminate vulnerability through building autonomy in the individualist model, or even only by defending individual rights (this would be limiting recognition to only one social imaginary). It rather aims to surface vulnerability and respond in a plurality of ways to build resilience, respect rights and to enable caring attachments. Recognizing vulnerability (as Ferrarese (2016a&b) argues) demands political responses but also reveals our embodied nature (insofar as vulnerability is a function of our physical or biological form), which changes the scope of political responses (see below).

While those demanding recognition necessarily have some agency, the result of political recognition is a full and rich form of political agency, in the form of full participation in society (as Fraser argues), by moral subjects or collectivities. In this way, recognition underpins the capabilities approach to justice (Sen 1993, 2001, 2009, Nussbaum 2000, 2006) also. The capabilities approach argues that sufficient conditions such as good health, education and emotional attachment, as well as financial income and other material resources are necessary for justice. Taken together such capabilities give individuals the ability to choose to live lives they value. Political agency is not simply one capability, but a requirement for achieving any other capability that requires collective action. Effective

political agency further embodies potential for social transformation by the inclusion of the uncounted and consequent reconstruction of institutions, rather than implying paternalist inclusion in the existing social order.

This interpretation may appear to resemble liberal accounts of mutual acceptance of diverse values, conditioned on acceptance of liberal freedoms, but it is distinctive. From this perspective, conventional liberal accounts are too thin in one dimension - rooted in individualism, such that they misrepresent moral subjects, missing care, attachment and affect; yet too thick in another – demanding acceptance of a fairly broad set of initial conditions – derived from a particular cultural and historic setting - rather than the single demand of reciprocal solidarity (a mutual commitment to inclusion as a common goal).

While this account endorses familiar procedural justice approaches of participation, voice, and standing found in the liberal paradigm (McLaren 2012b, McLaren, Krieger and Bickerstaff 2013) in contrast to standard liberal theories, it also rejects 'impartiality' as a value or virtue, in favor of Young's emphasis on proportionality as a response to difference. Impartiality is rather understood – as by Young - as a denial of difference and a rejection of emotion and affect, feeding cultural imperialism and legitimating authoritarian (technocratic) hierarchy. Impartiality also constitutes a single public, a tendency exacerbated by Anthropocene framings that construct a single global humanity – which overlooks both distribution and difference.

However this account does not romanticize recognition (a critique leveled by McNay (2008) at most normative accounts of recognition). It does not deny that (mis)recognition can be deployed – intentionally, or emergently - as an exercise of power; but as Schlosberg (2007) argues, recognition is fundamentally about resisting unjust power structures. Nor does this account assume a simplistic model of agency: recognition does offer a form of agency, but one still constrained by habitus, discipline and elite power (all of which may result in forms of mis-recognition). Nonetheless recognition decreases the asymmetry of power, and empowers different cultures and different ways of knowing, contributing to epistemic justice (Fricker 2007, Bohman 2012). And above all it increases the potential for the newly empowered agents to generate disruptive dissensus (Velicu and Kaika 2015), challenge the terms of the social contract, and reconfigure the moral community. Not only does it broaden the moral community, bringing new groups into a social contract, but it can reconstruct the terms of that contract, and even the underlying principles, such that it extends beyond questions of distributive and procedural justice typically addressed in the liberal social contract, to a more plural inclusion of restorative and care-based approaches.

This account of recognition consciously echoes Rancière's understanding of post-politics and politics proper, which sees the territory of politics as that where the demands of the unheard become heard. As Velicu and Kaika (2015) remind us, such invisibility is not overcome by an official act of recognition. They suggest instead that this requires the embodied performance of justice – transforming the unheard into conscious political subjects. For Velicu and Kaika political subjectivity and agency is neither simply demanded nor granted, but enacted and performed (which of course might also generate demands for recognition). The result is in Rancière's terms, a repartitioning of the sensible, a transformation of political institutions. Ingram (2006) similarly applies a Rancièrian perspective to politicize recognition. Such disruptive transformation of practices and habits can potentially even reconfigure the mainstream doxa (Velicu and Kaika (2015) citing Swyngedouw).

Yet Rancière tells us little about the moral obligations of citizens already within the community, and his model cannot speak to circumstances in which the unheard have no practical means to express their demands (e.g. future people or non-humans). So although post-political framings dominate the issues of climate and CGE (as identified in *Paper 4*), to overturn these requires granted forms of recognition for future people and possibly even also for non-humans and environmental systems. The account here also differs from Rancière in that by establishing recognition as a relational process that triggers caring attachments, it suggests richer forms of political subjectivity. McNay (2008) however, suggests that recognition essentializes identity and agency, arguing that a sophisticated account of subjectivity must understand self-identity as inherently indeterminate, and that even narrative accounts of identity are misleading in their vision of a coherent intrinsic self. She contrasts recognition accounts with those rooted in habitus, with the latter suggesting a form of co-production of ideas of subjectivity and ideas of justice. But these in turn suggest that a pursuit of recognition could reconfigure conceptions of justice as well as conceptions of the self. By problematizing and politicizing identity, as recognition encourages us to do, we end up with a possibility of pursuing justice that otherwise seems impossible in McNay's vision of subjectivity. Clearly if one simply sought to apply recognition without problematizing identity, the results would likely be simplistic, objectivist and individualistic ideas of recognition of an essential self-identity. By problematizing identity as part of the outcome of contested processes of recognition we can grasp both at the multiple dimensions, values and relational and situated influences that are constitutive of our sense of self and agency; and at the influences that structure and constrain them.

Individualized and essentialized accounts of identity are rooted in the administrative social imaginary, notably the dominance of rational over affective knowledge and reasoning (Lawler 2008). Our identities are rather constructed relationally, through relations of both care and vulnerability (as neatly summarized in the African concept *Ubuntu* which, in the maxim 'I am because you are,' suggests that such relationships are constitutive of our identities). While a concept of identity does co-constitute an essential other (at individual or group level), this does not inevitably lead to exclusion and othering, which is rather exacerbated by the asymmetric cultural and structural power and discipline that enables identities of others to be imposed not chosen (McNay 2008). Legibility or transparency of the relations underlying identities offers one tool to expose the effects of such power and discipline, as well as providing an inherent measure of the quality of relationships in terms of care. Exclusion is also exacerbated by the individualist model of identity (as described by Lawler 2008) which, moreover, suppresses connectedness and relationality, leading to mis-recognition. Identity projects and associated recognition can therefore be, politically, tools of governmentality and discipline, or tools of revolution and transformation, rather than necessarily one or the other.

5.5 Recognition, vulnerability, care and restoration

My efforts here are in part rooted in a belief that the relational construction of identity is both fundamental to subjectivity, and normatively valuable. Although, as McNay (2008) demonstrates, harmful identities are also constructed relationally, caring relationships are necessary to individual growth and development, and uncaring relationships between parents and children are the exception not the norm. This relational requirement of human upbringing, growth and identity makes us vulnerable to uncaring relationships too. So if we are to understand the potential for normative political subjectivity in recognition it is essential briefly to consider care and vulnerability, as I do below.

Where the dominant social imaginary sees vulnerability at all, it is as a weakness: a shortfall of autonomy. But in a care based imaginary vulnerability plays a much more sophisticated role. Vulnerability is a consequence of our affective and embodied humanity (Sayer 2011, Ferrarese 2016a&b). It reminds us of the universal need for care, but also of the deep variations in that need (Ferrarese 2016a), not least as a result of people's differential vulnerability to climatic impacts (*Paper 5*). Considering vulnerability helps focus our attention on the relationality of justice: in contrast to distributional concepts of poverty or marginality, which describe a condition or characteristic, someone is vulnerable in a

relationship to someone or something else (Ferrarese 2016a). In most conventional approaches to justice, vulnerability appears as a weakness. Even in a capabilities setting, vulnerability appears as a lack of significant capabilities. But vulnerability is a foundation for building and strengthening relationships of care and trust. In the same way as O'Neill (2013) argues that building trust requires one to make him or herself vulnerable to the other as a way to demonstrate trustworthiness, so do reciprocal relationships of care benefit from openness about (or legibility of) vulnerability and need.

As a psychological need mutual recognition brings moral and psychological vulnerability into the center of the human condition. We are vulnerable to (and dependent upon) our fellow humans as only they can grant the recognition we crave. The vulnerability of our personal worlds and our attachments requires us to face up to our condition of dependency on the care of others (Laugier, cited by Ferrarese 2016a). Vulnerability and dependency vary in their intensity across our lives (Groves 2014, Held 2006) and in relation to our relative capabilities and autonomy (Sen 2009). Insofar as our capabilities are collective results of communities, commons and public authorities rather than instilled in the individual, they emphasize our interdependence rather than autonomy. Equality of the differentially vulnerable demands a legal or political expression of care. In modern societies the law defines vulnerability in terms not only of physical weakness, but questionable autonomy or inability to consent (in thinking of children, or mentally deficient persons for example). Fair treatment of such groups requires their interests to be defended or represented in some way, typically by the state or the system.

Generalizing, it could be suggested that the less one enjoys agency and autonomy, the more vulnerable one is. In other words vulnerability is the opposite of power. This implies an inverse relationship between recognition and vulnerability (as seen in the vulnerability of unrecognized groups seen in *Paper 2*): but the foregoing discussion suggests that vulnerability per se is not necessarily problematic. Clearly if vulnerability is exploited (deliberately or incidentally) this will result in harm and likely injustice. On the other hand when vulnerability itself is recognized, it underpins interdependency and care as a political challenge. Ferrarese (2016b) highlights a constructive "tension between constitutive vulnerability and unequally shared vulnerability" (p153). Exaggerating the former, in a narrative that constructs all subjects as dependents, could indeed contribute to a lack of political awareness of difference, from the opposite side to the liberal framing of universal human rights. But whether all humans are seen as dependent or as autonomous, such an outcome would contribute to the Anthropocene fallacy of a 'single humanity'. In this setting,

a managerial approach to vulnerability would risk a sort of moral corruption in which imagined autonomy permits those of us who are citizens of modern western states to ignore our impacts on vulnerable others, and our complicity in long histories of oppression. By contrast, a care-based imaginary rooted in a political approach to recognition that responds also to activist and movement demands for recognition (Schlosberg 2007, Fraser and Honneth 2003, Agyeman 2013, Walker 2012) would acknowledge vulnerability and interdependence, and stimulate a moral obligation to recognize both our complicity and our capacity to act to make recompense.

Through a care-based lens, demands for recognition are rooted in the protection or restoration of our constitutive relationships of care, attachment and vulnerability with communities, cultural objects, values, norms, places and institutions. For Groves these attachments are constitutive of our selves as 'narrated identities' and call forth emotional, interpretive, practical and ethical agency to 'care for the future' despite its deep uncertainty. Justice as recognition cannot be achieved without care for these constitutive webs of relationships.

Recognition lies at the heart of care-based imaginaries in at least three ways. First, as argued above, it is central to the possibility of transformation by the inclusion of the previously unheard. Second, recognition of individual, specific or situated vulnerability and needs is essential to care (Held 2006), and specifically to care that seeks to establish or restore capabilities for full agency, functioning or flourishing (which is inconceivable without such situated consideration of to what and whom the subject of care is vulnerable). And third, recognition of the ways in which harms are done as a result of the administrative imaginary establishes (or implies) duties of repair, reconciliation or restorative justice.

Recognition of both victims and perpetrators as part of society is a central tenet of restorative justice practices as responses to crime. Forward looking rights – the central tool of the liberal social imaginary - are arguably a smokescreen (Meister 2011) without backward looking restorative justice. Reconciliation and restoration in a care framework means more than apologies and financial compensation. Indeed in the Rosia Montana case considered by Velicu and Kaika (2015) many families rejected compensation as that would have commodified their suffering (and accepted the neo-liberal imaginary, rather than expressing their own cultural values). In the climate case, restorative justice might imply accelerated mitigation paid for by those complicit in climate colonialism (Malm 2016), or measures such as repayments of the climate debt, and reparations for slavery and colonialism. In a care-based interpretation repair takes on new significance: relationships

themselves are subjects of care and repair (Held 2006). In this light, mutual recognition is a healthy form of relationship, while mis- or mal-recognition is not. Abusive and exploitative relationships can be repaired (at least in part) by establishing recognition, and enabling the prospect of reconciliation or restoration. Moreover understanding repair as time-bound, taking place in a specific period, in response to past events, and with implications for future events, helps draw attention to intergenerational justice. It can assist in the identification and acknowledgement of historically embodied misrecognition, and highlight the ways in which we stand in relationship to both past and future people.

5.6 Implications for climate change and CGE

Finally in this chapter I revisit the issue of CGE as a response to climate change, and seek to apply a political approach to recognition, explaining its relevance and significance in achieving a just approach.

The challenges of climate change are in many respects failings of recognition. Those concerned about climate change need to openly acknowledge difference. As Hulme suggests:

"Our discordant conversations about climate change reveal at a deeper level all that makes for diversity, creativity and conflict within the human story – our various different attitudes to risk, technology and well-being; our different ethical, ideological and political beliefs; our different interpretations of the past and our competing visions of the future. If we are to understand climate change and use it constructively in our politics, we must first hear and understand these discordant voices, these multifarious human beliefs, values, attitudes, aspirations and behaviors" (2009:ii-iii).

Understanding this process of 'hearing and understanding' as one of recognition not only allows us to approach this from a solid normative foundation, but also endorses a rich political response to it.

Other scholars have suggested that CGE raises particular demands for attention to participation and recognition. Hourdequin (2016) elaborates four reasons with respect to SRM in particular: first, the global scale; second the risks and uncertainties involved; third, the intentionality inherent in CGE; and fourth the absence or inadequacy of processes for dispute settlement in this space. Whyte argues that for those engaged in early SRM research, recognition implies actively seeking consent from indigenous peoples with distinctive world views, noting that the 'lesser evil' argument for SRM is another case where

expert judgments of significance and urgency might be permitted to override and silence dissenting views from indigenous peoples.

Such arguments might appear to be founded largely in a liberal ethical stance within the dominant paradigm. They imply a move from top-down consultation and consent, to a more active participation in decision-making processes, perhaps through the sorts of deliberative mechanisms used in *Paper 3*, and by Bellamy et al (2013, 2014), or Cairns and Stirling (2014). Yet they perhaps still beg the question of whether such participatory parity enables such groups to begin the redefine the processes through which participation is achieved, and through which participation leads to political change.

It is clear that the participatory turn in research on emerging technologies in recent years has led to much deeper and richer discussions (Chilvers and Kearnes 2016, Pidgeon et al 2013, 2014, Pidgeon and Rogers-Hayden 2007, Wynne and Felt 2007, Groves 2014; Stirling 2014). But it is also clear that the processes co-create new publics, often in ways that reproduce researchers and policy makers expectations of the technologies involved (Chilvers and Kearnes 2016, Wynne 2016, Stirling 2014). In the same way as existing power relations mold individual identities (McNay 2008), so do existing power relations shape the publics with whom researchers engage (Bellamy and Lezaun 2015, Groves 2017).

Turning public participation into real political recognition suggests a further step towards invented rather than invited forms of participation (Scandrett 2013), in which insurgent groups co-define not only their identities, but also the processes through which they are recognized. The practical working through of such processes is beyond the scope of this document, but they will inevitably be iterative as identities in turn are redefined in engagement, and engagements are restructured to include new identities – including those taken on and mobilized by representatives of those groups unable to directly participate (especially future generations).

The implications of such a reworking of participation, politics and social imaginaries are deep and broad. They encompass the whole of climate policy, ideas of progress, development, technology and more. Again mapping out these implications is impossible within this thesis. But until this process is begun, to pursue current technological imaginaries of CGE appears counter-productive, simultaneously sustaining the current social imaginary and its discriminatory relations, and risking locking into a technological pathway with high risks and continued domination in the climate sphere.

But genuine recognition underpins a possibility of restorative justice for those harmed by climate change, and the nexus of inequalities around fossil fuel extraction and use. In this context the substitution of CGE for accelerated mitigation by high emitting groups and countries, and adaptation financed by the rich world, appears especially problematic. To view CGE as a possible form of compensation for climate harms (either in the 'arming the future' mode (outlined and critiqued by Gardiner 2010) or in actual deployment), relies on an assumption that CGE is a supplement to mitigation, or at least a good substitute for it. But even if CGE were to have the same impacts on objective climate risk, to substitute it for approaches with a corrective or restorative element would appear *prima facie* unjust.

SRM technologies, with their relative low cost and high leverage appear particularly vulnerable to such an effect. CDR on the other hand might offer a remedial tool (*Paper 5*) despite the risk of it being advocated to transfer costs to future people. Habib and Jankunis (2016) argue that CDR could be deployed to provide compensation or fulfill a corrective 'polluter pays' principle. This depends greatly on who pays. I suggest that CDR might best function as a remedial approach if responsibility to bear its costs were divided on basis of historic cumulative emissions (for example), and further compensation were provided to address any distributed inequalities arising from its deployment (such as competition for productive land for growing food).

I am not claiming that distributive justice arguments for CGE rooted in questions of climate and economic inertia (outlined in section 1.1) would disappear with a care-based imaginary. The material conditions of the Anthropocene appear unforgiving, and there may still be a need for CDR or even SRM in a just future.[18] But to decide so now seems premature at best and damaging at worst – insofar as the pursuit of CGE acts to reconstruct and sustain the unjust dominant imaginary (then the 'need for CGE as the lesser-evil' becomes a self-fulfilling prophecy).

[18] The Anthropocene setting offers a further argument for supplementing distribution and procedure as justice concepts with recognition and restoration. The ways in which non-human species and systems are both affected by human impacts, and exhibiting agency in the transforming world of the Anthropocene suggests a need to recognize non-human communities and even non-living agents better too. I hope the work presented here regarding recognition for spatially and temporally remote others might also offer some pointers for such a process.

As a result, this analysis does not lead to an outright rejection of CGE, but to an understanding that the recognition of different groups, interests and values in the climate change space would imply a transformation of institutions and politics, particularly in response to the demand for restorative justice. In turn this might imply very different co-productions of CGE technologies or techniques (in particular, perhaps CDR techniques in restorative modes). In such modes and imaginaries, agency would no longer be reserved for the technocratic elite – with new technologies actively coproduced by communities on the ground in the global periphery, and imaginatively influenced by representatives of future people. Moreover, the interventions offered would no longer simply assuage guilty consciences in the rich North, but be embedded in the implementation of meaningful duties of restitution (financial and otherwise) for the harms of climate colonialism.

Chapter 6: Conclusions

In this final chapter I return to my research questions, and sketch out some implications for further research and future development of CGE that arise from my analysis.

6.1 Returning to the research questions

If climate justice requires recognition and restitution (as argued in Chapter 5 above), would the pursuit of CGE be just or unjust? I have argued in this thesis that an answer to this question is not a matter of empirical testing, nor something that can be suggested absent an understanding of the relationship between socio-technical systems and discourses, and the social imaginaries that structure contemporary societies globally.

CGE discourses – particularly in SRM forms (as outlined in *Paper 4*) - tend to establish a series of framings which reinforce the dominant social imaginary. They help constitute the chimera of humanity as a single, undifferentiated entity in the Anthropocene, with great technological power and leverage (a technological optimism); and common interests (albeit as individual rational consumers) rather than political disagreement. They suggest a post-political analysis (in which politics has failed to deliver mitigation), and help constitute a post-political subject through the technocratic methods of research and the implied administrative reliance on expertise. Moreover, they tend to draw a clean sheet over historic injustice, which rejects restorative approaches or restitution. Nonetheless, within the dominant social imaginary, solar geoengineering might be seen as reducing climate harms particularly for those in the present and near future who would otherwise suffer most. There is a similar case for carbon geoengineering as a means to reduce future climate harms in ways that disproportionately benefit those worst affected.

But such arguments are predominantly distributional, consequential and even utilitarian in the ways they portray justice. They rely on idealized modeling, and some optimistic assumptions about technology and politics. In particular they are rooted in specific discursive framings of the climate problem which reflect the dominant (modern (neo)liberal) social imaginary. And they are implicitly 'lesser evil' arguments: seeing any injustices in delivery of CGE as acceptable because they are less than those in unabated (or only partially abated) climate change. I do not claim that the underlying arguments for CGE rooted in questions of climate and economic inertia can be imagined away, but to decide so now risks sustaining the unjust dominant imaginary and making the 'need' for the 'lesser-evil' of CGE a self-fulfilling prophecy.

The most serious issue remains that of mitigation deterrence. Contributing to justice through CGE tends to presuppose that mitigation continues (and is even accelerated), rather than being deterred or delayed. Yet both CDR and SAI would appear to have characteristics that would play out politically in the latter way, with – at an extreme – SAI being adopted by previous climate deniers as a continued argument against the economic (redistributive) effects of mitigation. Mitigation deterrence would likely exacerbate any distributional injustices arising from CGE – with for example, even more land required to offset delays through CDR. Moreover, the extreme outcome of mitigation deterrence by SAI would be a severely unjust domination of future life conditions behind the veil of SAI.

So I reach the conclusion that climate geoengineering as currently proposed and framed is inherently unjust and unfair, primarily because of the ways in which it could be expected to act to sustain neo-liberal administrative imaginaries and politics. In the worst case many existing injustices would be maintained and exacerbated, while the risk of actually catastrophic climate change might even increase, given the difficulties in ensuring practical delivery of the socio-technical promises of CGE and the impossibility of retrospectively enhancing mitigation to compensate afterwards, should such failings arise in the future.

Approaching the central question from the plural understanding of climate justice elaborated here leads to a similar conclusion. Climate justice requires both broad and deep recognition, and restorative justice (which in turn also relies on recognition). But CGE in current forms rooted in the dominant imaginary denies such recognition, flattens difference, simplifies identity (essentializing individualism), and thus acts against restorative justice and climate justice more generally. It treats restoration as a functional environmental concern, rather than a matter of justice and social solidarity. In this CGE echoes instrumental and consequential discourses of 'sustainable development' in contrast to those of 'just sustainabilities' which center equity, justice and recognition (Agyeman 2013).

In this context, making CGE visible is the ethical challenge, not making it invisible. The discursive normalization of CGE in climate policy narratives, the seamless integration of CDR into climate pathways and carbon markets, and the concept of the 'perfect particle' for SRM which would avoid whitening skies (see *Paper 5*) all share the same problem from this perspective: they act to conceal CGE from public critique and reflexive examination, making it technocratic and administrative in form (a coherent part of the imaginary that has spawned it). Moreover in this reading, CGE is mobilized to repair not the climate, but capitalism, providing new 'invisible' forms of maintenance to supplement those on which it relies, but actively conceals and devalues.

Contemporary social imaginaries in the Anthropocene not only repair and reconfigure (neo)liberal capitalism, but structure CGE: they exacerbate the risk of mitigation deterrence and moral hazard; and generate centralized, depoliticized, technocratic, undemocratic and sometimes even authoritarian imaginaries of CGE. These are not just a feature of SRM discourses but extend to CDR, for example in terms of control over land productivity through market mechanisms, or even land grabbing.

Locating this work in discourses and imaginaries of the Anthropocene not only exposes the catastrophism of current climate discourses but also highlights the depoliticized, homogenized and universal narratives of contemporary humanity (in which agency is transferred to an unspecified collective humanity, but in practice to a moneyed and technocratic elite). Resisting such universalizing narratives through political recognition is a second critical task of visibility and exposure.

As a paradigmatic 'Anthropocene' technology CGE promises power to change not only the world, but also our very conceptions of what it is to be human. As human beings we desperately need to understand better the politics of climate change and geoengineering in an age of humans. As researchers, we must explore the ways in which our responses to climate change are socially embedded and ethically loaded. And we need to understand and practice ways of doing research that don't stimulate moral hazard or authoritarian depoliticization of climate action.

These are fundamentally practices which seek to recognize the values, identities and interests of the diverse others who have a stake in the climate, enabling those values, identities and interests to enter, at least notionally, into participatory dialogues to inform CGE research; and practices which seek to properly recognize our own selves, interests, identities and values in reflexive ways. As Stilgoe suggests: "reflexivity involves holding a mirror up to one's own social, ethical and political assumptions and being mindful of commitments, aware of the limits of knowledge and conscious that a particular understanding of an issue may not be universal " (2015: 37). This challenge applies as much to social scientists seeking to unsettle conventional narratives of technological progress as a means of managing risk, as it does to the natural scientists who tend to reproduce those narratives. But perhaps more critically, reflexivity also means acting on such reflections in the practice of research.

The analysis of recognition above suggests not that CGE is necessarily unjust, but that the task of transforming the politics of climate change and the underlying social imaginary –

through proper recognition on international and intergenerational dimensions - has to come first. Otherwise CGE will prop up the existing unjust dominant social imaginary. CGE may have a role to play in a restorative, care based imaginary (especially in CDR forms) but the details of its deployments, motivations and institutions (the full socio-technical system, rather than the simplistic technological imaginaries that dominate current debate) might well be (unimaginably) different.

6.2 What next?

This thesis has covered a lot of ground, and implications could be considered in many different spaces and dimensions. In this final section I want to briefly consider some suggestions for new approaches and directions in three areas: first for the future development and governance of CGE technologies; second for the practices of research into climate change and CGE; and third for the knowledge systems and disciplinary foundations set out in Chapter 3.

This research has suggested that the current pathways to development and deployment of CGE have largely unexplored and ill-considered political implications, especially in the form of moral hazard or mitigation deterrence. Mechanisms so far proposed to manage and mitigate this problem are very limited and sketchy (*Paper 1*). Future research needs to escape the dominant social imaginary to focus on understanding how the effects are produced and reproduced, with a normative orientation of seeking to elucidate ways in which mitigation can be encouraged, rather than deterred by CGE research and development.

Escaping the dominant imaginary implies new practices for research that enhance participation in both dialogic and agonistic forms, informed by recognition, as a means of intervening in the co-construction of socio-technical systems of CGE. Reinventing participation, as suggested by Chilvers and Kearnes (2016) in deeply reflexive forms, acutely aware of the responsibilities of researchers in constituting publics is one necessary step. More dialogic techniques of research design, management and investigation all require development. Research should be explicitly embedded in a normative commitment to inclusion and solidarity – recognizing a social purpose and explicitly resisting capture by powerful corporate or political interests.

But in many respects the conclusions of this thesis are directed less at CGE research and development than at the research and engagement needed to improve our understanding

and implementation of justice principles, through the reconfiguration of dominant knowledge systems and social imaginaries.

The political account of recognition set out in Chapter 5 offers lessons for knowledge systems broadly across diverse research disciplines. It challenges both the dominance of scientific disciplines and the quest for universal theory, suggesting respect for diverse knowledge systems as a practical implication of recognition. Respect implies a dialogic relationship to enhance understanding, but not actively to seek to synthesize or integrate the systems, and certainly not to replace or assimilate diverse approaches into the dominant system. Respect therefore reflects 'interculturalism' (Tully, 1995) rather than the multicultural liberal ideal of the melting pot. But this is not some equally idealistic concept of a mosaic of separately preserved knowledge systems: rather one in which each system is alive and developing in co-evolution with the others, in the ways that food, music and artistic cultures develop and cross-fertilize in the modern world. It suggests inter- or trans-disciplinary research practices that respect rather than assimilate, and thus create spaces for reconfiguration of knowledge systems (in the same way as recognition enables transformation of political systems).

These principles must extend to teaching as well as research, where pedagogies of popular education, and active efforts to 'decolonize' curricula in line with diverse knowledge systems can introduce ethical pluralism. Such pluralism in knowledge – both epistemological and ontological – avoiding the lure of universalism (with its need to discredit or subsume alternatives), is also coherent and consistent with pluralism in justice.

As well as these general directions for research – suggested as ways to open up possibilities for new social imaginaries - I also want to note a few specific lines of research and investigation within the four foundational approaches suggested in Chapter 3.

One of those foundations was the understanding of social imaginaries and their role in structuring and constraining our political and intellectual imaginations, a role this thesis has confirmed in many respects. Yet I hope I have also revealed social imaginaries as a mechanism whereby discourses constitute the world as we know it, and as a space of political contestation – perhaps the most important one. That suggests a critical role for conflict in forms that can unsettle, disrupt or break existing social imaginaries, and subsequently for dialogue that can help reconfigure and repair them. The mechanisms by which social imaginaries structure social relations and futures by acting on political agents, and vice versa merit further research and development.

I also drew on sociology and political science for concepts of agency and power. In developing a political account of recognition the relationships between recognition, identity and agency came to the fore. In particular I identified a case for the problematization of identity and the various ways in which identities can be imposed on others by powerful agents, structures, practices or even technologies. This too demands further research and exploration to understand the mechanisms involved, and ways in which ethically responsible interventions to repair identities can be designed.

In drawing on STS I recognized the ways in which technology constrains and enables moral agency. In this thesis I have sought to resituate STS in normative values, affect and evaluations, equally rejecting conceptualizations of technology as wholly autonomous or as entirely objective. I have also emphasized the significance of repair and maintenance over innovation and invention of novel technology for the achievement of social and environmental purpose. The implications of repair and the virtues or ethics of its practice for STS merit further exploration.

And in using environmental justice as a foundation I emphasized pluralism. Yet I found so little academic material (in English) on non-western concepts of justice. In the thesis I have made a case for supplementing conventional distributive and procedural approaches to justice with recognitional and restorative dimensions. I have noted already the need for further development of ideas of recognition for future generations and non-humans; and on the related tension between granting and demanding recognition. In line with the understanding of recognition as an expression of intercultural transdisciplinarity, I see a case for broadening justice research beyond philosophical reasoning to include also more pragmatic approaches to understanding emergent virtues, ethics or norms. In the light of the intriguing findings of *Paper 3* on emergent public conceptions of justice, and the lack of intercultural comparisons in this space, further public engagement and deliberation in a variety of countries and trans-national settings would be desirable. A similar approach would be of great interest in elucidating the virtues or ethics of repair sketched in *Paper 5*, given their possible variability between cultures and disciplines.

More generally, I hope I have enriched discussion of technological agency and coproduction with a stronger normative orientation, and embedded it in a clearer understanding of the ways that new configurations of technology, identity and justice can reshape social imaginaries. With respect to human agency to influence technology, Stilgoe argues that "Although we overestimate our ability to control technologies once they are fully formed, we underestimate our ability to shape science and innovation while they are still emerging"

(2015:23). This research would support Stilgoe's conclusion, but highlight it as another effect of the dominant social imaginary. My conclusion is that the dominant imaginary so constrains our capacity and imagination to influence science and innovation that unless we can reconfigure it from a critical normative perspective, humanity will fail to harness science and technology to deliver social and environmental goals.

The dominant social imaginary and dominant discursive framings of the Anthropocene are tightly entangled. The research reported here would suggest a need also to reconfigure our understandings of the Anthropocene. Rather than either 'catastrophic consequence of human impact' or a new 'promethean age of humans acting as gods' I suggest we need an ethics of repair and reconfiguration for the Anthropocene, yet one which is radical and transformative, not conservative in impulse: there is no sustainable society to which we can return.

Paper 5 explores one way in which ethics of repair and associated concepts of restorative justice can contribute to such a transformative politics, contrary to commonplace framings of repair as politically conservative or sustaining. In this context political conflict can be understood as a never ending cycle of breakage and repair which embraces the idea of Jackson's 'broken world' (2014) as the standard state of affairs, but also endorses a subversive or even revolutionary politics of breaking and repair, while unifying disruptive politics with restorative justice.

In this light repair is a necessary part of a political process of dissensus and conflict, rather than the practical expression of a utopian vision of wholeness. Such a cycle of breaking and repair seems essential to overcome the oppression of imposed identities, and to enable care to flourish. This does not however imply a moral impulse to break and repair the natural environment in the same way: that would be committing a naturalistic fallacy in reverse!

Afterword

In this thesis I have argued for a plural conception of justice, reflecting the plurality of human culture and experience, in the face of the universalizing discourses and social imaginaries of contemporary neoliberalism. Yet this is not the only plurality revealed by the mirror of my title, the mythical item from the tale of Snow White that assesses and judges 'fairness'. The mirror itself is plural: also the dark glass in which humans seek to peer into a murky and indeterminate future, and above all, the reflexive process in which humans co-produce and re-configure conceptions, behaviors, norms and ethics so as to better care for the world. By recognizing these plural reflections and reflexivities, and in particular by turning the mirror on ourselves, our quest for climate justice in the Anthropocene may become realizable.

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Annex 1: Statement from co-authors on Paper 3

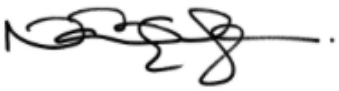
To whom it may concern

We the undersigned and co-authors of the paper entitled 'Public Conceptions of Justice in Climate Engineering: Evidence from secondary analysis of public deliberation', published in *Global Environmental Change*, Vol 41: November 2016, hereby confirm that Duncan McLaren (of the Lancaster Environment Centre) was the principal author of this piece, taking primary responsibility for the secondary analysis of previously collected data reported in the article, for the drafting of text, and for the submission and subsequent revision of the article.

Signed:

Karen Parkhill, University of York, 3rd July 2017

Adam Corner, Climate Outreach, 29th June 2017



Naomi Vaughan, University of East Anglia, 19th June 2017

Nicholas F. Pidgeon, Cardiff University, 10th July 2017