7 Radical solutions and consistent imaginations

> I always was sceptical. I started out sceptical about climate engineering. I'm still sceptical about it. But being sceptical is not enough. If we have more issues with climate change, such as droughts or hurricanes coming more frequently and affecting more people more severely, we might have a real shift in opinion. People might ask their governments, 'Do something against these storms. Do something against these droughts.' Then it might not be enough to just say, well I feel sceptical.
>
> (Researcher E)

A synoptic view of reality

For the better part of the 20th century, climate change was simply a scientific curiosity, a vast geophysical experiment to be tracked and understood. For scientists in Sweden and Russia, global warming was even *desirable*. As late as the 1960s, some scientists in the Soviet Union still hoped to *warm* the climate to make their country more hospitable. For a long time, the most influential scientists, located in the United States, the USSR, and Europe, also understood climate change as a local problem. Climate change could certainly have catastrophic effects locally, but it wouldn't halt the steady march of civilisation. As scientists started to worry in the 1970s and 1980s, those localised worries started to change. It became clear that climate change is not *just* a local problem; it is also a global disruptor of ecosystems and societies. Everyone is at risk. At the same time, it is clear that not everyone is equally vulnerable. For many developed countries, climate change is a problem of the future—not one in the present. Even then, they are often confident about their ability to adapt. Among the world's poorest and most vulnerable, there is no such luxury. As the world's political and scientific power remains mostly concentrated in developed countries, often in temperate or colder climate, even now there is complacency about climate change. The voices of those most vulnerable to climate change are not voices that can make themselves heard. One cannot help but wonder: would global warming have been taken more seriously sooner if the scientific centres of power would have been located not in the United States, England, and Russia, but in Brazil, India, and Iraq? At the same time, our contemporary global systems of measurement owe a lot to the militarized 20th century. Climate change came into view through those systems of measurement. Events such as the International Geophysical Year, as much Cold War politics as legitimate scientific interest, and the development of the 'surveillance imperative' through satellites and digital computing lie at the heart of the discovery of climate change. This raises another question: would our scientific appreciation of climate change have developed as timely as it did without Cold War incentives to construct a vast observational machine?

Such counterfactual questions matter. History is contingent on cultural and geopolitical developments, and the future of the climate change debate is too. Social factors, cultural imaginations, and geopolitical drivers deeply influenced the story of climate change. As we have seen throughout this book, they continue to influence the development of climate engineering. At the moment, the future trajectory of climate engineering is still unclear. Both its development *and* its predominant sociotechnical imaginations are still being negotiated. We can never know now what counterfactuals we will ask about climate engineering research in 50 years. Will people lament our opposition to technological fixes? Will they be angry about the current (implicit) reliance on negative emissions? Or will they simply be glad to have solutions to the worst effects of climate change?

Through climate change, the related biodiversity crisis, and the 'Anthropocene' as a whole, it is inevitable humans will influence planetary systems—that they are in fact already doing so. Climate engineering is a particularly controversial manifestation of that newly acquired capacity, because it is, in Jeremy Baskin's (2019) words, *climate-shaping* and *world-making*. Simply by virtue of engineering the climate, one would augur in a new world, including new human-nature and interhuman relationships. As such, climate engineering presents a choice about future pathways and future worlds. The way we imagine and view such future pathways and imagined futures matters intensely, as such visions bring particular future worlds into being. *How* we collectively view and imagine climate engineering, as world-making enterprise, matters. Like any imagined future and technological intervention, climate engineering comes into view as a potential 'solution' to climate change through selective reductions in complexity. Because climate engineering technologies propose very specific interventions in highly complex systems, they can only be made to work *through* such reductions. In the words of James C. Scott,

> certain forms of knowledge and control require a narrowing of vision. The great advantage of such tunnel vision is that it brings into sharp focus certain limited aspects of an otherwise far more complex and unwieldy reality. This very simplification, in turn, makes the phenomenon at the center of the field of vision more legible and hence more susceptible to careful measurement and calculation. Combined with similar observations, an overall, aggregate, synoptic view of a selective reality is achieved, making possible a high degree in schematic knowledge, control, and manipulation.
>
> (Scott, 1998, p. 11)

Climate engineering technologies—and climate engineering as an imagined *set of approaches* to climate change—rely on such a synoptic view of a selective reality. Through the development of a global epistemology, it became possible to imagine 'whole Earth' technological interventions—and an 'Anthropocene'. Not only did it become possible to measure and assess climate change through models, carbon dioxide measurements, and satellite imagery (Edwards, 2013), it also became possible to imagine climate change as a global problem (Howe, 2014; Jasanoff, 2001). As climate change became a global problem, climate engineering could be imagined as a global solution. This facilitated yet another set of reductions in the discursive complexity of climate change—idealised conceptions of society as a collection of self-interested individuals and states as rational self-interested actors for example. Likewise, political and scientific storylines[1] about 'safe' levels of global warming and 'safe' carbon dioxide concentrations set a stage for solar radiation management (SRM) and carbon dioxide removal (CDR) to address those simplified problems. If average global surface temperatures are the most important metric of climate change, SRM addresses precisely that problem. If, instead, carbon dioxide concentrations are the main indicator for climate change, then CDR might solve it. For climate engineering to be imaginable, a range of complexities have to be narrowed. SRM and carbon removal at scale will always be *socio*technical systems. They don't just address environmental conditions and the climate system; they also exist in complex human societies. Successful implementation of both CDR and SRM—whatever measure of its success is used—will need to account for the resilience and wilfulness of natural *and* social interactions.

A synoptic view of a selective reality is necessary to make particular forms of control and manipulation possible. A synoptic view of the climate—looked at through the prism of the 1.5°C or 2°C goals and the global carbon commons—makes it possible to specifically target those indicators and to address them using technological interventions. Such interventions may alleviate the worst effects of climate change, but they also push out of view unexpected 'side effects' and uncertainties (Jasanoff, 2003; Scott, 1998; Sterman, 2012). And as John Sterman reminds us, it is important to recognize that

> there are no side effects–just effects. Those we expected or that prove beneficial we call the main effects and claim credit. Those that undercut our policies and cause harm we claim to be side effects, hoping to excuse the failure of our intervention. "Side effects" are not a feature of reality but a sign that the boundaries of our mental models are too narrow, our time horizons too short
>
> (Sterman, 2012, p.24)

Departing from an assumption of predictability, large-scale technologies (such as climate engineering) tend to account for the intrinsic concerns of its designers. But 'super-wicked problems' such as climate change and other unexpected consequences of modernisation do not function within clear schemata. Super-wicked problems are *defined* by the difficulty to 'bring into sharp focus certain limited aspects' because there is always disagreement about what synoptic view of reality is the right one; time is running out, there is no clear (epistemic) authority, the people trying to solve the problem are simultaneously causing it, and policies do not (and often cannot) account for future irrationality and unpredictability (Levin *et al.*, 2012). Climate change and climate engineering are wicked problems precisely *because* they resist attempts at reducing complexity to manageable levels. Because both the geophysical complexity and the sociopolitical complexity are enormous, major disagreements about what the field of vision of climate engineering should be reduced to are inevitable. Which aspects should be at the centre of the field of vision? Which should be retained as a supportive structure, in an instrumental way? Which effects will be 'side effects' and which will be the 'main effects'? And, importantly, who gets to reduce the field of vision along which lines? Who decides the selective reality climate engineering addresses?

Climate engineers are in a continuous battle to pull the collective visions towards the epistemic territory they consider to be most important. Every scientific discipline comes with its own specific vision and lens through which to view the world. Specific cultural traditions and epistemological paradigms do too. None of these lenses are necessarily wrong—and many of them are useful—but none are all-encompassing or fully accurate. All such ways of seeing present particular discourses and imaginaries about climate change and climate engineering. Like modern societies as a whole (Porter, 1996), the climate engineering research community has a profound 'trust in numbers'. There is a tendency to prioritise technical knowledge that can provide clear and often numerical answers. Questions like whether carbon absorption is possible at scale; whether in an ideal-type political world stratospheric aerosol injections (SAIs) or other SRM methods would reduce climate risks; how climate engineering technologies might interact with one another; and how the economic and monetary cost of climate engineering compares to conventional mitigation. These questions are undoubtedly important, yet in their clearly delineated space they are also limited, closing down an inherently political debate to technical questions—to questions about the reliability of particular technologies and the validity of particular scientific findings. Growing parts of the climate engineering research community feel uncomfortable about this foregrounding of technical questions. They advocate for a more intimate understanding of non-technical questions and for questions that arise when different communities, be they academic disciplines or activists or politicians, meet. Rather than closing down along particular synoptic views of reality, they would prefer to *open up* more complex questions about the intersections between climate politics, technological developments, and morality. Climate engineering is precisely so interesting, so controversial, so unsettling, and so complicated because more than ever before, none of these questions can be separated. Technical systems are never just technical; they are always *socio*technical. Model representations are never merely factual; they are always designed with certain questions and assumptions in mind. Questions around liability of SRM technologies, how to attribute the climatic effects of SAI, or the hydrological or biological effects of certain CDR measures can only be explained by combining the human and the natural sciences. Questions about democracy and SRM can never be answered without engaging in what democracy is, how democracy is imagined to function, and for whom it works—but not without contemplation of the technical and physical requirements of SRM either.

Five types of climate engineer

Climate engineers continuously debate about which reductions in complexity are necessary and which are scientifically, politically, and morally defensible.[2] As the Anthropocene debate normalises the thought of human influence and human stewardship over natural systems, large sociotechnical interventions such as climate engineering interventions become ever more thinkable. The longer meaningful emissions reductions are delayed, the more climate engineering in some way, shape, or form seems inevitable. Slowly, the central premise of deliberately altering the climate becomes normalised. The question of how to research and develop climate engineering is becoming the new negotiation. In this normalising climate engineering debate, it is crucially important to zoom in on *what visions underlie those negotiations*. Different climate engineers have very different visions of what types of reductions in complexity are 'right' or 'defensible'.

To understand what is brought into view in the climate engineering debate (and how), this book offered up comparisons between different 'ways of seeing' aspects of the climate engineering. It often did so by juxtaposing those excited about the research of a speculative technology and those more opposed. Between those ways of seeing, there are clear continuities and connections, which can map roughly onto—often quite consistent—attitudes towards climate engineering. Here, it is time to tie the different ways of seeing the climate (the physical, Chapter 4), power and authority (the political, Chapter 5), and interventions and control (the moral, Chapter 6) together to more or less comprehensive imaginations of climate engineering. I identify five 'types' of climate engineer. Four types openly operate on a spectrum from supportive to oppositional: the *ecomodernist*, the *pragmatist*, the *reluctant climate engineer*, and the *disprover*. A fifth type, the *basic scientist*, does not neatly fit this spectrum, as they typically refrain from assessments about both the desirability and the feasibility of climate engineering. Instead, they use climate engineering research as a vessel to better understand the climate system.[3] Different types of climate engineer make distinct epistemological and normative choices. Of course, the distinction between these 'types of climate engineer' is analytical. No single researcher really embodies any type consistently. Yet keeping these types in mind does help to understand how views on the technical feasibility, political justification, and human-nature relationships tend to connect and intersect. These five of types have particular ways of seeing aspects of the climate engineering debate.[4] To return to John Berger's words, '*we only see what we look at. To look is an act of choice. As a result of this act, what we see is brought within our reach*'. These five types describe a worldview, which connects visions about science and technology to moral convictions about how the world should be. These connections are surprisingly robust. Engineering the climate is a political, ethical, *and* scientific dream (or nightmare). The political and the ethical are ever-present, even when the question asked is ostensibly a 'purely' scientific one.

On the techno-optimist side, *ecomodernists* feel genuine alarm about climate change but also trust in technological intensification and economic progress. This trust often ties to a barely (and decreasingly) hidden excitement about the potential of climate engineering. On the other end of the spectrum, *disprovers* are axiomatically opposed to climate engineering, which they see as both unreliable and undesirable. While they engage in climate engineering research, they focus predominantly on increasing the complexity of climate engineering proposals in an attempt to disprove its viability. Between these more rigidly defined positions, there are two types of climate engineer exhibiting a form of mediated techno-scepticism: *pragmatists* and *reluctant climate engineers*. Pragmatists are alarmed and apprehensive about climate engineering technologies but simultaneously willing to entertain the idea that climate engineering might seriously limit the risks of climate change. They often urge a 'pragmatic' attitude towards climate engineering. Similarly, reluctant climate engineers are willing to consider climate engineering out of despair about climate change, but are rather more sceptical about the idea of actively intervening in the climate. The final type of climate engineer, the *basic scientist*, does not map neatly on this spectrum—or at least doesn't want to. They eye climate engineering predominantly from the perspective of basic science and from the question of what could be learned about the Earth's many natural systems rather than the question of how (and whether) climate engineering could be applied. Often, these basic scientists are deeply sceptical about the feasibility of climate engineering technologies, but they do not see it as their scientific prerogative to make any judgements about it. Rather, they view climate engineering as an interesting *thought* experiment—often not to be fundamentally tried out in the real-world experiments at all.[5]

The techno-optimism inherent in ecomodernism is rather comfortable with particular reductions of complexity. In order to make climate manageable, ecomodernists appreciate global models and global trade-offs as the most important measures of climate. As we saw in Chapter 4, they are *climate knowledge optimists*, convinced that climate science (and the global lens) can give reliable enough information to seriously consider climate modification. They trust in climate models as semi-accurate descriptions of future climates—and as models addressing the *right types of concerns* for climate engineering too. As such, they are optimistic about the technical feasibility of both SRM and CDR. This techno-optimism ties to particular views on politics and human relations. In order to make climate politics comprehensible, ecomodernists—pragmatists often too—favour rationalist, individualist ideas about human behaviour as a proxy for both individual preference and state politics. In such a view, as we saw in Chapter 5, the governance concerns are questions of rational decision-making—an aggregate of individual preferences. The risk of a moral hazard, for example, depends primarily on individuals preferring climate engineering over conventional mitigation—not on implicit, collective, and structural processes. This rationalist view of human behaviour—in combination with their techno-optimism—of the ecomodernist and (to a lesser extent) the pragmatist in turn brings the idea of a 'Good Anthropocene', in which humans become responsible stewards of the biosphere, into view. Through deliberative governance, it is conceivable not only that humans *can* control the biosphere, they could also conceivably *manage* this justly.[6] In this globalized worldview, the idea of what Duncan Mclaren calls 'geopower', the management and disciplining of natural systems, is attractive (McLaren, 2020). Those more sceptical about the feasibility of climate engineering, whether SRM or CDR, often resist those particular reductions. For disprovers and reluctant climate engineers, the complexities of both the climate system and political relationships are so vast that they could never be reduced to manageable proportions. To them, precisely by making certain aspects more legible, other issues are foregone. Instead, they attempt to reintroduce layers of complexity—often with the specific aim of problematising climate engineering technologies. In their eyes, global temperature scales gloss over both the (unpredictable) regional specificities of the climate and the cultural and political aspects of climates. As such, models should not be regarded as accurate descriptions, but rather as exploratory tools to give a *sense of direction*, not actual information. As *climate knowledge pessimists*, they fear the 'side-effects' of climate engineering technologies—and think the political system is not adequately prepared to deal with them. Rather than privileging the liberal idea of rational individuals and states as aggregates of such preferences, they choose to focus on *structural* and *collectivist* constraints on decision-making. In their eyes, the rationalist individualist view of climate politics flattens climate politics, uniformising cultural concerns and political inequalities in favour of an economically computable view of the human. Such a flattened climate politics presents climate engineering as subject to fair deliberation, while in fact differentiated discursive and political power means such decisions can never be 'a rational political debate'. As such, 'geo-management' is not only impossible but also undesirable. Instead, a more humble ethical relationship with nature is needed. A 'Good Anthropocene' therefore does not require stewardship, but rather *humility* in the face of the irreducible complexity of the natural and human world—and attentiveness to its systemic inequalities.[7]

Table 7.1 Ways of Seeing Climate Engineering

	Ecomodernist	*Pragmatist*	*Reluctant Climate Engineer*	*Disprover*	*Basic Scientist*
Knowability of the climate	Climate knowledge optimism	(Mediated) climate knowledge optimism	Climate knowledge scepticism	Climate knowledge pessimism	Climate Knowledge Pessimism
Technical feasibility of SRM	Likely	Likely—but unpredictable	Likely—but (too) unpredictable	Fundamentally unreliable	Unlikely
Technical feasibility of CDR	Feasible, necessary, and affordable	Likely—though perhaps not at required scale	Likely—though certainly not the required scale	Unclear—certainly not without severe side effects and drawbacks	Unclear – certainly not without severe side-effects and drawbacks
Politics of climate engineering	Liberal individualism—aggregate of individual self-interest	Predominantly liberal individualism	Predominantly constructivist and structuralist	Constructivist and structuralist	—
Moral hazard	Individual aggregate—jury is still out	Individual aggregate—jury is still out	Structural risk—likely	Structural risk—highly likely	Structural risk – highly likely
Hands on the thermostat	Tractable problem—important role for scientists	Tractable problem—important role for scientists—need for structural co-design of governance	Intractable risk of technocracy and geopolitical tensions	Intractable risk of technocracy and geopolitical tensions	—
'Good' Anthropocene	Active human stewardship	Active human stewardship	Humility	Humility	Humility
Desired discontinuities	Environmentalism as retreat from nature	Economic system Environmentalism as retreat from nature	Economic system Technological hubris	Economic system Technological hubris	—
Desired continuities	Technological intensification	(Limited) trust in science and technology	Environmentalism as retreat from nature	Environmentalism as retreat from nature	—

Selective realities

Many members of the German SPP, typically sceptical about climate engineering and uncomfortable on the centre stage of a contentious political debate, tried to open up the climate engineering debate to difficult moral and political questions. Although some members decried the SPP as 'only weakly interdisciplinary', there were serious attempts to resist the reduction of complexity that comes with the development of technological systems. *Assessment, not development* appeared not just as a research credo but also as a mindset. Assessment of speculative technologies *can* mean opening up—and it sometimes does. Development, on the other hand, *needs* to reduce complexity to, in Scott's words, 'make possible a high degree in schematic knowledge, control, and manipulation'. This is clearly visible in the counterpart of my empirical research, the David Keith Group. While conceding that philosophical concerns of justice, for example, are important, the general research culture of the David Keith Group prioritises *problem-solving* research. Tying to the more predominantly ecomodernist and pragmatists views on climate engineering, such problem-solving research focuses on how climate engineering, SAI specifically, could be made to work. What types of governance could safeguard fair and safe SRM implementation? How could the right economic (dis)incentives be developed? What scientific and technical capacities need to be developed to implement SAI safely? Often, questions of morality and justice functioned merely as rhetorical veneer, even as a rhetorical justification for climate engineering research.

As Chapters 4–6 have made clear, particular reductions in complexity can make climate engineering appear more feasible, more reliable, more governable, and more desirable. And inversely, introducing more levels of complexity renders climate engineering more uncertain and more problematic. This is why, when it comes down to it, proponents of climate engineering research and development prefer to reduce the issue to two simple vectors: a climate-changed world without climate engineering and a climate-changed world with climate engineering. Often, this comparison facilitates economic comparisons of projected GDP and damages, temperature maps of the world, precipitation maps, hurricane projections, and political and social comparisons.[8] In narrowing the focal point, such a comparison between a climate changed world with or without SRM and CDR narrows the scope of the effects that can be imagined as part of climate engineering implementation. It also re-enacts the importance of carbon dioxide concentrations and global average surface temperature. Simultaneously, it oversimplifies, deliberately, difficult questions about social justice, about negative consequences and responsibility for them, and about political organisation. Such fundamentally important questions and risks become 'side effects'—dangerously close to collateral damage. It asks, in the non-ironic words of a development-minded researcher, 'how much losing will offset all the winning'?

Such a simplified storylines should never be allowed to dominate climate engineering discourse. Climate engineering technologies have the potential to change the fabric of society, geopolitics, *and* the natural environment. Intimate connections between early climate scientists, 'weather warriors' (Fleming, 2010), and the military-industrial-academic complex (Giroux, 2007) still shape the kinds of imaginaries we hold about the role of (climate) science in the climate change debate. They have provided the large observational networks, computing centres, and many of the climate modelling institutions that determine our view on climate change—and that make climate engineering imaginable as a *global* solution. Climate engineering history is inculcated by Cold War considerations, with a climate science inseparably intertwined with the 'surveillance imperative' (Turchetti and Roberts, 2014). Despite attempts to address such concerns and to *reimagine* climate engineering as a scientific response to climate change rather than a political tool, climate engineering should always be treated with the political lens that it warrants. Contemporary climate engineering's *world-making* capacity means that it is important to consider not only the global aggregate but also what Duncan McLaren and Olaf Corry call 'the situated' aspects of the (geo)future (McLaren and Corry, 2020)—the structural constraints and inequality, the power imbalances, the subjectivities built into models, and cultural specificities.

Stories of continuity and rupture

Particular ways of seeing climate change and climate engineering—as a global collaborative action problem, as a local and cultural concern, or as a market failure for example—highlight certain concerns and privilege certain views over others. The desirability of climate engineering is determined by the imaginative framework built around it. At the moment, the discourse around climate engineering is dominated by the technical imaginations of climate engineering researchers themselves—which, as we saw in Chapters 4–6, are continuously being negotiated and questioned. Climate engineers, in conjunction with activists, the general public, and politicians, are trying to shape the conversation around climate engineering because they feel that *their* vision for the future of climate engineering is the right one. Because the majority of its research takes place in Europe and the United States, the confines of this imaginative framework can be rather narrow. The vast majority of the climate engineering researchers come from Europe and the United States, instilling certain Western-centred conceptions of climate change, climate engineering, and the political world into climate engineering discourses. The majority of the climate engineering researchers, especially in the positions of power, are male. Few of them are in a particular position of vulnerability. The vast majority of researchers also identify as democratic, capitalist, pro-growth, and 'liberal', which inherently limits the range of options that are seriously considered and the way that its governance can be imagined. The predominant epistemologies of these researchers, even the characters in their integrated assessment modelling, rely on liberal individuals and rational decision-making. All of this makes the stories they tell about climate change and their ways of seeing quite homogenous—and their perception of climate engineering risks mathematical and utilitarian.[9]

As Anshelm and Hansson (2014) note, climate engineering might be the first truly post-modern technology in the way it is imagined and proposed—a complex, value-loaded solution for modernity's ills. In this story, climate change is so dire that any and all technologies—metaphorically at least—that could help reduce the human and non-human suffering already (and soon to be) locked into the climate system should be treated with utmost care and serious consideration. The exact shape of this narrative—and what climate engineering is imagined to *contribute* to a desirable future—is in continuous debate. Which considerations and selective reductions of complexity—which storylines and which imaginaries—shape the debate on climate change will play a crucially important role in the future of climate engineering. The constitutive visions of such storylines and imaginaries, based on *ways of seeing the climate, politics, and the Anthropocene*, provide clear indications about the likely storylines and imaginaries of future climate engineering. Such constitutive visions inevitably rely on imaginations about continuity and rupture—as well as views on *which (dis)continuities* are desirable. What imagined traditions are climate engineering researchers willing to re-enact, and which do they want to break with? Such questions co-determine how people imagine the future of climate engineering. Does climate engineering present a reprehensible *break* in human-nature relationships? Does it *perpetuate* and *re-enact* particular assumptions about the role of science and technology as the saviour of humankind? Is climate engineering the logical next step in the human history of tinkering with the environment, or is this fundamentally different?

W*hich* (dis)continuities one chooses to focus on determines which kinds of visions of the climate and climate engineering one can hold. For many, a central concern of climate engineering is metaphysical: does adopting an active stewardship of the planetary environment change the relationship between humans and nature? And, importantly, can that ever be desirable? Many opponents of climate engineering quiver at the idea of 'techno-fixing' the climate.[10] To them, climate engineering continues modernist hubris and continues the imperial drive to dominate nature—from which they would like to break. The influential techno-sceptical NGO *ETC Group*, for example, sees an intimate connection between the dreams of GMOs, nanotechnology, and climate engineering, tapping into ontological and metaphysical arguments about human hubris. Disprovers, reluctant climate engineers, and even pragmatists view the imagining of climate engineering as a radical departure from earlier human-nature relationships—and they are not amenable to this prospect. They view and present it as a continuance of hubristic attempts to control nature, while simultaneously narrating it as a radical break in human nature relationships—as 'the end of nature' (Baskin, 2019). To many of them, climate engineering represents an attempt to justify and perpetuate a whole imaginative structure: a highly problematic world-order and economic system. In this view, climate engineering technologies flow from the same imaginations that facilitate the denial, obfuscation, and obstruction of collective climate action. It is a hyper-rational and reductive way of looking at the world that facilitates centralised decision-making and bureaucracies.[11] For other groups, such as the ecomodernists, such technological modernisation is not the issue. For ecomodernist climate engineers, climate engineering might simply present a conscious break with traditional (post-)modern environmentalism. Instead of dreaming to reduce the human influence on nature, this story goes, the Anthropocene implores us to shoulder responsibility as responsible stewards, wielding human influence safely and deliberately. Breaking with previous conceptions of human-nature relationships, this story insists that environmentalist dreams of reducing human footprint on ecosystems are *outdated*, that a 'Good Anthropocene' *necessitates* human stewardship. They argue against what they see as a post-modern attempt to retreat from nature, precisely *because* such an attempt continues the modernist ideology that humans and nature can be separated—a mode of reasoning they in turn would like to break from. Oliver Morton, for example, closely aligned to the ecomodernist wing of climate engineering research and author of *The Planet Remade* (2016),[12] ties climate engineering to what he sees as a fundamental human drive to intervene in and control nature. According Morton, humans have been 'geoengineering' at least since fundamental interventions in the nitrogen and phosphorus cycles started a century ago. To him, there is no fundamental moral distinction between interventions such as fixing nitrogen and phosphorus, on the one hand, and intervening in the climate, on the other. Since other large-scale technologies have already 'remade' the planet, what would be fundamentally different about climate engineering? Seeing such a continuity makes it easier to justify extensive development of climate engineering technologies.[13] Correspondingly, they—as Oliver Morton (2016) does in his *The Planet Remade*—see climate engineering as the logical extension of changes people have been making to nature for centuries. As such, climate engineering is not particularly new (or problematic) but rather the culmination of a trend towards human stewardship.[14]

Climate engineering might be a nightmare, a pipe dream, or it might represent 'newfound tools as an expression of collaborative human effort to understand the natural world' (Keith, 2013, p. 174). Such visions form coherent narratives and imaginaries about the role of science and technology, the wilfulness of natural systems, and human relationships as well as human-nature relationships. Clearly, they all hinge on imagined relationships with history. All imagined climate engineering futures want to break from parts of an 'imagined modernity'—while wanting to retain other parts. In the eyes of disprovers, the imagined modernity is one of scientific hubris, technocracy, and dangerous 'side-effects'. In their eyes, modernity might have brought great benefits; it also brought unprecedented technological risks and inequalities—and we shouldn't dream of compounding such risks. In the eyes of the ecomodernist, on the other hand, faith in science and technology is a desirable continuity. Their 'imagined modernity' provided unprecedented economic growth and improvements in living conditions. Instead, their imagined break is with the modernist idea that humans can separate or retreat from nature. Climate engineering simply presents an acceptance of this fact, and the stewardship of a Good Anthropocene is a desirable future to work towards. Both continuity and break can be seen—and performed—as *desirable*. Which continuities people seek, and which they oppose, informs us about the world they want to live in—and the world they imagine to be part of.

Historical continuities: implementing the technofix

Storylines about continuity and break are clear indicators of what is imagined as the desirable future people want to work towards. At the same time, it is also important to trace *historical* continuities and discontinuities that inform such visions. To conduct their research, climate engineers rely on the same economic and industrial systems that caused climate change. They operate in the same imaginative structures around the climate, nature, culture, and society. By necessity, climate engineering research operates within the confines of thinking and decision-making of the dominant imaginations of science, technology, and society. This means that in many ways climate engineering *is* the unsurprising outflow of cultural and social norms that prescribe science and technology to find control over a resistant and resilient nature. Unwittingly and inevitably, climate engineering re-enacts and challenges certain myths about the role of science, of the temerity and malleability of nature, playing into the socioeconomic and sociotechnical structures that have created the climate crisis. As I outlined in Chapters 2 and 3 and reiterated in Chapter 4, the global epistemology that allows for climate science to understand climate change as a global phenomenon also allows for particular imaginations climate control. Despite the realisation that the climate manifests, at least primarily, locally, the current rendition of climate engineering research has historically focused on whole Earth solutions—especially among development-minded researchers. The manifestly unequal results of different SRM technologies, for example, are often viewed as unwelcome *side-effects*, the unintended consequences of a global 'solution'. The implicit reliance on carbon capture at scale in the latter half of this century, moreover, suggests that an imaginative system around intervening in the climate already existed, making possible imaginations of climate engineering.[15] The normalisation of GDP as a measurement system of welfare (Raworth, 2017), the normalisation of discount rates as a means of predicting and economising the future (Deringer, 2018), and the broad adoption of the 2°C goal for climate mitigation (Beck and Mahony, 2018; Gasser *et al.*, 2015; Geden, 2016) are examples of how particular ways of seeing the world influence the *type* of desirability we can see. Many institutional structures seem primed for certain forms of continuity—for using climate engineering, negative emissions in particular, as a *technofix* that will allow some modicum of 'business as usual'.[16] Reducing climate change to two important indicators, global mean temperature and CO_2 concentrations, presents these two indicators as ontological placeholders for climate change, coding for complex storylines about unpredictable effects. They make climate engineering seem attractive precisely because they provide a clear synoptic view of the world—one that is comprehensively addressed by technocratic solutions. As such, it is crucially important understand how the imaginative and discursive normalisation of climate engineering takes place and along which lines.

Conclusion

One might narrate the history of the climate change debate in the 20th century and early twenty-first century as a series of crises, of moments of breakage. One could also stress the continuities, the consistency in the imaginative space around human-nature relationships and the biosphere. Both stories could be equally accurate. Which story we tell and which ways of seeing we privilege in addressing climate change matter. Because climate engineering presents a familiar mode of problem-solving in as many ways as it presents a rupture,[17] it seems likely that I will see many of the technologies implemented in my lifetime. As I outlined in Chapters 4 and 5, many carbon capture technologies are already part and parcel of the climate policy envelope. Although climate engineers doubt whether such carbon capture at scale will succeed, they have no doubt that negative emissions will become increasingly prominent in the climate debate—even if climate engineers wish they didn't.[18] Climate inactivity has now become so institutionalised—and collective awakening to the dire reality of climate change so slow—that climate engineering presents itself as a direly needed plan-B, a possible escape from the worst environmental disaster—or just disaster *period*—in the history of human existence, a disaster wholly of humanity's own making. But climate engineering technologies might also represent one of the strongest technocratic drivers against the systemic changes needed for environmental repair. Both CDR and SRM exacerbate environmental 'cockpitism' (Hajer *et al.*, 2015), technocratic and managerial approaches to climate change that exist in direct tension with more democratic, just, and empowering ways of governing and organising our world. As we have seen throughout this book, climate engineering proposals directly result from our predominant imagination of climate change as a *global scientific problem*. Jeremy Baskin is spot on when he asks pessimistically, 'is it possible that the currently predominant paradigm approach to climate policy, combined with the climate prognosis, is now able to generate only dystopian imperial ideas like [solar geoengineering] or magical, colonial thinking like BECCS' (Baskin, 2019, p. 261)?

If an instrumental, optimistic view of climate engineering prevails, a global cockpit thinking about the climate globally might facilitate utilitarian stories about distributed 'winning and losing'. If the Earth needs to be managed, with a *good steward* at its helm, a centralised technocracy might be imagined as representative of the needs of an ill-defined 'humanity'. If, on the other hand, our visions are redirected to local and cultural considerations of climate, climate engineering might never come into view as a viable option.[19] In short, sleepwalking into climate engineering is dangerous. Without accurate scrutiny of the instrumental values underlying many of the *ways of seeing* of the climate engineers—and their imaginaries (Baskin, 2019)—climate engineering could well be the dystopian future Baskin fears it is. It might prove disempowering and technocratic, and could cause immense suffering and irreversible consequences. In this book, then, I have attempted to shed a light on what different aspects of the climate debate are at play in climate engineering—what imaginative spaces of possibility exist for climate engineering research and development. The 'ways of seeing' highlighted are part of a modest attempt at opening our collective eyes. It is a call to critically examine where our convictions on climate engineering come from, what they perpetuate, what they rupture, and what the consequences may be. It is an attempt to open up the synoptic view inherent in climate engineering discourse and research. It is my call to avoid simply dreaming a designer climate into being—and an investigation on which and whose visions such ideas of a stewarded climate rest. What climate engineering *is* and *will be* depends on the stories we tell and the imaginaries we share. Those stories and imaginaries in turn depend on underlying ways of viewing the climate, politics, and human-nature relationships. In climate engineering, several underlying convictions are exorbitantly influential: global economic growth, though perhaps measured differently, is needed for global development to guarantee all people on Earth a life worth living; people are likely not willing to give up material wealth for climate change mitigation; it is the province of science and technology to provide solutions for pressing issues and to provide the betterment of human kind; science provides impartial facts upon which other people can act; making democratic decision-making about climate engineering possible should be a central aim of the development of its technologies. The discussion about what climate engineering entails for the climate, for society, and for humanity takes place mostly within these confines.

Thus far, our global political discourse has emphasised the technical. It has treated climate change too often as a scientific problem with scientific indicators—and too sporadically as a cultural, political, and moral concern. It is *this* discourse that brings climate engineering into view, a technologically intensive solution predicated on ways of seeing the climate and the future as a technical concern, measurable in global temperatures and carbon dioxide concentrations. If we want to critically assess climate engineering—without dismissing it out of hand—we need better stories. We need to reorient our ways of seeing away from the numerical to the cultural and political. We, as differentiated communities with different interests and power, should try to understand what it means to entertain the notion of climate control. We should seriously question what synoptic views animate the development of such capacities and what the focal points are of research. Even more pressingly, we should be trying to understand what the (geo)political, geophysical, and *cultural* effects might be of intervening in the climate. As such, the negotiation over which ways of seeing climate engineering to prioritise, and which selective reality to privilege, is a discursive and imaginative battle for the right to shape the visions of the climate future. Informed by historical, cultural, and technopolitical imaginations on the role of science and technology, this is a struggle to determine *what the future of the world should look like*.

Notes

1 As Maarten Hajer reminds us, storylines 'have the functional role of facilitating the reduction of the discursive complexity of a problem and creating possibilities for problem closure' (Hajer, 1997, p. 63).
2 This is also why social scientists have called to 'open up' the climate engineering debate before narrowing the options and the conversational space (Bellamy *et al.*, 2013) and critically assess metaphors (Nerlich and Jaspal, 2012) and imaginaries of climate engineering (Baskin, 2019).
3 As most *basic scientists* view the climate and biosphere as incredibly complex systems, however, they often align intuitively with disprovers: trying to show that those complexity simply cannot be reduced to manageable levels.
4 In an earlier version of this book, I used those five types of climate engineer, with their own idiosyncratic views, as a consistent analytic tool throughout the book as a whole. I removed this classification in the empirical chapters in favour of bringing *ways of seeing* more clearly to the fore, instead of a laboured attempt to show the full consistency of climate engineering attitudes. The classification here doesn't hold strictly, but I add it here in the final chapter, because it gives a good sense of how different ways of seeing connect to one another.
5 Climate engineers often move intermittently between different positions. They might do so because it is politically and scientifically expedient, or just because they—like me—cannot make up their minds about the feasibility and desirability of climate engineering. But a disprover the one moment is never an ecomodernist the next. Basic scientists often share views with disprovers, while pragmatists and ecomodernists also align often.
6 Jeremy Baskin (2019) refers to such ideas as the 'geo-management' imaginary.
7 See Table 7.1 to see how the particular visions addressed in Chapters 4 through 6 tie in together.
8 To be frank, I personally find the comparison between a world with climate change and a world with climate change *and* a host of climate engineering technologies both compelling and convincing. Given the current trajectory of anthropogenic climate change, I can imagine many circumstances, politically and climatically, in which a climate engineered world is infinitely more desirable than one that isn't. But that doesn't mean that climate engineering is *desirable*, nor does it mean that this narrow comparison is an apt way of discussing climate engineering.
9 As sociological and psychological research has consistently shown over the past 30 years, such narrow confines likely entail a very different form of psychological risk assessment as well as the assessment of technological and environmental risks (Kahan *et al.*, 2007).
10 They conveniently forget that renewable energy, energy efficiency, and adaptation measures are also technological fixes, albeit ones that present other normative questions, other continuities, and other breaks. Even behaviour and consumption change, perhaps even cultural changes, are susceptible to the technofix, as they might be socially engineered.

11 It also privileges the rights of large corporations and countries over grassroots welfare—and perpetuates a system based on exploitation, of ill-conceived notions of domination and control.
12 Which is, in my opinion, the best book on climate engineering—despite the fact that I personally feel it is dangerously optimistic about the prospects of climate engineering and underestimates many of its political risks.
13 Inversely, if one is already extremely sceptical of human influence on the Earth's systems, seeing a continuity in climate engineering makes one less inclined to support climate engineering measures.
14 I would be inclined to add here that such a view 'outsources', in a way the ethical questions about such interventions to past technological interventions, leaving only questions of interpersonal justice and governance—and thus pre-empts important normative debates.
15 Recently, some of the climate engineering researchers have even started arguing that it may be possible to *slow* mitigation somewhat—provided that extensive mitigation starts in the first place—in order to leave underdeveloped countries more time to develop. In this vision, the industrialised West would keep its obligation to mitigate as fast as possible, while developing countries are allowed to use carbon-heavy technologies for a while longer to build up their economies.
16 The United Nation talks about sustainable development, projecting an economic growth that has not yet been decoupled from increasing research use; fossil fuel companies still get permission for further exploration and exploitation of fossil fuel resources; and no society is designed in such a way that it can do without growth nor fossil fuels.
17 And vested interests clearly have and hold a stake in both delaying climate measures and profiting from eventual climate engineering measures.
18 As is discussed frequently at workshops and conferences from wide-ranging academic disciplines, many of the climate engineers are sceptical about the reliance on NETs in these scenarios. Additionally, they anticipate widespread resistance against many of the more land-use intensive and environmentally invasive technologies.
19 Which, to be fair, might also prove deeply consequential.

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