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Messing with nature? Exploring public perceptions of geoengineering in the UK ☆☆

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ABSTRACT

Anthropogenic influence on the climate – and possible societal responses to it – offers a unique window through which to examine the way people think about and relate to the natural world. This paper reports data from four, one-day deliberative workshops conducted with members of the UK public during early 2012. The workshops focused on geoengineering – the deliberate, large-scale manipulation of the planetary environment – as one of three possible responses to climate change (alongside mitigation and adaptation). Here, we explore one of the most pervasive and wide-ranging themes to emerge from the workshops: whether geoengineering represented an unprecedented human intervention into 'nature', and what the moral consequences of this might be. Using the concept of 'messing with nature' as an analytical lens, we explore public perceptions of geoengineering. We also reflect on why 'messing with nature' was such a focal point for debate and disagreement, and whether the prospect of geoengineering may reveal new dimensions to the way that people think about the natural world, and their relationship to it.

1. Introduction

Over the course of millennia, the way that people have imagined and perceived the natural world has changed repeatedly and often dramatically (Williams, 1972). Shifting belief systems have provided vastly different filters through which people have come to understand the relationship between society and 'nature' (Franklin, 2002). New socio-technical developments, both ancient and modern, have often acted as foci for disputes and contestations about the impacts of human activity on the natural world (Macnaghten and Urry, 1998). Developments such as Genetically Modified Organisms (GMOs) and nanotechnology are particularly imbued with potential for changing the way society interacts with nature (Shaw, 2002). Geoengineering – the term used to describe large scale technologies that could counteract the effects of climate change – is the latest in a series of emergent technologies to raise serious questions about whether, and to what extent, societies' activities 'mess', 'tinker' or 'fiddle' with nature (Shaw, 2002; Davies and Macnaghten, 2010). In this paper, we seek to reflect on the views of members of the British general public regarding geoengineering and the implications for how society relates to nature.

In the first part of the paper, we provide a brief outline of the multiple and often contrasting ways in which scholars and commentators have conceptualised our relationship with the natural world, including a discussion of how anthropogenic climate change (and possible responses to it) offers a unique window on how people think about 'nature'. We then summarise what is known about public perceptions of geoengineering, explaining why the perceived naturalness of certain geoengineering proposals–like other emerging technologies before them – plays an important role in people's views.

Next, we provide an analysis of four deliberative workshops held with members of the general public during the first half of 2012, using the concept of 'messing with nature' as a lens for extracting a subset of the data, relating the findings from these workshops to previous empirical and theoretical work that has sought to understand how people conceive of, and relate to nature. Finally, we conclude by offering some reflections on how geoengineering may add yet more dimensions to the way that people think about their relationship to the natural world, and what this might mean for discourses about nature in the future.

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2. Theory and concepts

2.1. Society and 'nature'

The question of how people relate to, and conceptualise 'nature' is deep-rooted and multi-faceted (FitzSimmons, 1989; Franklin, 2002; Macnaghten and Urry, 1998; Murphy, 1994; Williams, 1972). There is no single, straightforward way that nature is understood in everyday language. It is used to describe green spaces of ecological value (i.e., parks, forests, grass and trees), anything that is not directly of human creation (where the crucial distinction is between natural and artificial), and much more besides.

Ideas about what the natural world means, and where we see our place in it, have changed repeatedly over centuries of human development (Dryzek, 1997; Murphy, 1994; Williams, 1972). The ancient Greeks were among the first civilisations to posit that there could be a singular entity – nature – that captured the huge variety of non-human phenomena that people observed around them (Macnaghten and Urry, 1998). This did not mean that nature was well-understood, but it was considered something *understandable*, and by extension, potentially measureable and malleable to human influence. Indeed, one of the enduring Greek myths is that of Prometheus, who stole fire from the God Zeus permitting humans to shape nature in a way that had previously been the domain of the Gods.

Interpretations and uses of the word 'nature' are historically and culturally specific. As Enlightenment thinking and the scientific method swept through Western societies, followed by the Industrial Revolution and all that it entailed for social processes and technological sophistication, the idea of nature as something mysterious and un-knowable changed rapidly. In its place, a more mechanistic concept was born: nature as a set of laws, rules and processes that could be observed, learnt, harnessed – and perhaps even controlled. As 'man' became separate from nature through the formulation of 'natural laws', the doctrine of human exceptionalism gained popularity: that humans are fundamentally different from, and superior to other species. In contrast, the Romantic movement's emphasis on nature as pure, pristine and original was a direct response to the increasingly popular empiricism of the Enlightenment (Macnaghten and Urry, 1998), and has informed ecological philosophies ever since.

While human exceptionalism has become dominant in many Western societies, prior to the second half of the seventeenth century, the distinction between 'animate' and 'inanimate' objects was not even recognised (Hamilton, 2010). Similarly, the idea that 'nature' means 'the natural environment' is a relatively recent idea (Macnaghten and Urry, 1998). For some, nature has come to be equated with an environment that is under attack, can be measured and sustained, and needs protection. The New Ecological Paradigm (NEP – see Dunlap et al., 2000, for discussion) is an attitudinal scale aimed at capturing the apparently paradigmatic shift in public views about nature in the 1970s, as an awareness of the global (and potentially highly damaging) effects of human activities became clearer. The general principles on which the environmentalist philosophy is based are widely endorsed in surveys that measure environmental values (De Groot and Steg, 2008 – and see Yearley, 1992, or Cotgrove, 1982, for a discussion of the relationship between the environmental movement and Enlightenment 'rationality').

Dryzek (1997) has described the seeming shift in the way that people conceptualised nature (and their relation to it) during the 1970s as indicative of a 'survivalist' narrative, drawing on the rhetoric and terminology of the 'Limits to Growth' report released by the Club of Rome in 1972 (Meadows et al., 1972). The limits to growth thesis – put crudely, that infinite economic and population growth cannot be sustained on a planet of finite physical resources – was one of several key publications that were considered to mark a new level of engagement with the natural environment (see also Carson, 1962), and the underlying logic has continued to be used as conceptual tool for examining the human relationship to the natural world. In fact, recent attempts to define modern history as the 'anthropocene' re-invoke the limits to growth concept but express it through much more precisely calculated (and ecologically grounded) boundaries and parameters (Zalasiewicz et al., 2008, 2011), while the imaginations of technologists and scientists has repeatedly been fired by the prospect of transcending the limits of the natural world (e.g., Drexler, 1986)

Castree (2001) asserts there are three 'typologies' of nature: *External nature* – whereby 'nature is external to, and different from society'; *Intrinsic* nature – where nature is 'an inherent and essential quality' of something; and *Universal nature* - where nature is seen as encompassing everything there is, including humans. Hansen (2006) notes that nature can be characterised as good and pure (i.e. pristine), as vulnerable and threatened (i.e. degraded), as a threat itself (e.g., natural disasters), as a challenge (e.g., mountainous terrain), and also as a force not to be tinkered, tampered or otherwise interfered with. Nature is sometimes seen not as 'natural', but as having been created *to be* natural (Stepan, 1991 cited from Gregory, 2001) – indicative of a conceptual progression in human geography and environmental sociology that challenges the idea that it is even possible to talk about 'nature' as independent from our experience of it (Castree and Braun, 2001; FitzSimmons, 1989; Franklin, 2002; Irwin, 2001; Macnaghten and Urry, 1998). According to this perspective, 'nature is social nature' (Cloke et al., 1996, p. 534).

However, even this attempt at broadening out the concept of nature has attracted criticisms. Whilst important, it is only one – not *the* – conceptualisation of nature (Dickens, 1996), and many scholars have expressed concerns that viewing nature through the lens of social constructionism promotes an overly abstracted level of theorisation. Theoretical stances on nature continue to evolve, but for the purposes of the current discussion, the message is clear: nature is constructed, socially and politically, in many different ways and for many different purposes making it a "powerful and flexible construct in virtually any public debate or controversy" (Hansen, 2006, p. 813).

2.2. Nature and emergent technologies

One area in which the relationship between society and the natural world has played a particularly central role is emerging technologies – both in terms of how the public perceive them, and the dominant narratives in media coverage and stakeholder debates or contestation. Because some new technologies alter or mediate the way that people interact with their natural environment, they have frequently acted as lightning rods for debates about appropriate levels of human intervention in natural processes (see e.g., Sjöberg, 2000).

Perhaps unsurprisingly, given that agricultural biotechnology literally involves manipulating the genetic structure of plants (a highly iconic representation of 'nature'), concerns about messing with nature have been central to debates about genetically modified (GM) crops, as well as the cloning of animals. For example, in a Eurobarometer survey reported by Gaskell et al. (2000), a majority of respondents (both supporters and opponents of biotechnology) agreed that GM crops and animal cloning 'threaten the natural order' and (despite potential benefits) are 'fundamentally unnatural'.

Durant et al. (1996) analysed media coverage and public understanding of the Human Genome Project, and identified two competing discourses – one of hope, and one of fear. The discourse

of fear identified culturally deep-seated images of 'out of control' scientists playing God, abusing their knowledge, and interfering with nature. Similarly, an analysis of public dialogue around GM crops in the UK found that concerns about the unnaturalness of GM – and of scientists fiddling, tampering with, or otherwise inappropriately interacting with nature – were central and recurring concerns. In a review of the language and metaphors used in newspaper coverage of genetics and biotechnology from the 1980s through to 2003, Hansen (2006) found that references to 'nature' would frequently serve the purpose of linguistically identifying a clear, agreed upon boundary between that which is natural and 'good', and that which is un-natural and therefore open to question, or potentially wrong, immoral or unethical.

Nanotechnologies offer another pertinent example of the complex and dynamic way in which the boundaries between natural and non-natural processes are construed by scientists, policy makers, civil society organisations and publics. Offering the potential to 'engineer' at a sub-molecular level, analyses of the views of members of the public have identified concerns about blurring the distinction between natural (or religious) creation, and human control (Pidgeon et al., 2009; Scheufele et al., 2009). For example, the DEEPEN project identified five cultural narratives that characterised participants' responses to nanotechnology. One of these narratives – messing with nature – revolved around the idea that nanotechnologies violated a boundary between the natural and the artificial that should not be crossed (Davies and Macnaghten, 2010).

To understand views about nanotechnologies – like other emerging areas of specialist science with significant social and ethical implications – it is critical to understand the way in which people relate them to nature (Vandermoere et al., 2010). Perhaps the ultimate indication, though, of the intertwined relationship between society, technology and nature is anthropogenic climate change.

2.3. Climate change, geoengineering and the 'end of nature'

As the evidence of anthropogenic influence on the climate has grown ever-stronger (IPCC, 2007), so 'climate change' has evolved from a technical term – primarily of interest to scientists and policy makers – to a social, moral and political issue that has attracted a huge amount of media coverage (Boykoff, 2007), public interest (e.g., Spence et al., 2010) and social contestation (Hulme, 2009). Climate change – fundamentally a question of human impact on and influence over the natural world – is one of the defining challenges of the 21st century.

More than 20 years ago, the environmentalist Bill McKibben published a book titled 'The End of Nature' (McKibben, 1970). McKibben's argument, put simply, was that natural systems could no longer be considered independent from human influence. The impacts of the industrial revolution had grown steadily as they had become more globalised, and what might once have constituted relative local processes, with relatively local impacts (and in a pre-globalised world, very little chance of comparing 'local' conditions to those elsewhere), now operated on an international scale, with international effects. More recently McKibben noted, anthropogenic climate change marked a definitive shift in how humans influenced the natural world: global systems were now fundamentally linked to choices made by human societies.

> "By the end of nature I do not mean the end of the world. The rain will still fall and the sun shine, though differently than before. When I say 'nature' I mean a certain set of human ideas about the world and our place in it." (McKibben, 2003, p7).

Whilst many (e.g. Macnaghten and Urry, 1998) have argued that nature has never been independent from human activity, McKibben's thesis is provocative. Geoengineering – the deployment of large-scale technologies to counteract the effects of climate change – potentially takes McKibben's ideas a step further (Corner, 2013). If the relatively recent human capacity to impact on natural systems at a global scale really does represent a distinct phase in human–nature relations (i.e. the 'anthropocene' – Zalasiewicz et al., 2011), then the prospect of geoengineering seems to add another conceptual leap. In a geoengineered world, nature is more than co-dependent on human activity – it is actively shaped, managed and controlled by it on an unprecedented scale.

In a relatively short period of time, geoengineering has moved from being a fairly obscure field of academic inquiry to an issue on the agenda of mainstream scientists, policy makers, and civil society groups–if not yet most members of the public (Royal Society, 2009; Corner, Pidgeon et al., 2012). Despite the long history of interest – from academics, the military and policy makers – in technologies for controlling the weather (Fleming, 2010), the idea that the climatic system could be intentionally manipulated as a policy response to anthropogenic climate change has only recently begun to attract serious attention.

The term geoengineering refers to a vast array of existing and putative technologies, which often have few features in common. Some of the technologies are familiar, but many have never been tested on a meaningful scale. The *only* link between these technologies is that they all have the potential to be deployed in order to control or alter the Earth's climate. Proposals for geoengineering technologies are frequently grouped into two broad categories – those that seek to remove carbon dioxide from the atmosphere (Carbon Dioxide Removal – CDR), and those that would reflect a proportion of sunlight back into space, in order to reduce solar radiation (Solar Radiation Management – SRM). There are many hugely significant uncertainties about the technical feasibility of geoengineering proposals (Royal Society, 2009; United States Government Accountability Office, 2011). But as with other emerging technologies before them, geoengineering proposals are likely to act as a catalyst for wider societal debates that reflect much more than simply an evaluation of the physical risks or benefits a particular technology may possess (Corner and Pidgeon, 2010; Rosa and Clarke, 1999; Walls et al., 2005).

Geoengineering is just the latest in a long line of technological developments that speak to the concept of nature, and how humans relate to it. Historians of science have observed how controversies regarding nuclear power (i.e. the risks of radioactive waste and the dangers of weaponisation) can be regarded as centring on nuclear power's capacity to violate the order of nature (e.g., Weart, 1988), and culturally deep-seated ideas about poisoning and contamination (Sjöberg, 2000). But as the tools and technologies we have developed for intervening in and manipulating the natural world have become ever more powerful, the stakes have risen. Where once a debate about society and its technologies 'overstepping' a boundary would involve fairly localised concerns–for example, over-intensive farming methods, the cleanliness of a park, or even a 'localised' radioactive leak – a globalised economy and exponential advances in technological capacity now offers the possibility of interfering with nature at a global scale.

Nerlich and Jaspal (2012) analysed the emerging language used in news articles to describe geoengineering and found that it was dominated by three overarching metaphors: the planet as a body, the planet is a machine, and the planet is a patient/addict. Within each of these metaphors are assumptions – or social 'imaginaries' – that speak directly to the way in which humans and the natural world are related, and how this is symbolically represented in our language, laws, values and cultural conventions (see, e.g., Macnaghten, 2010). Should we care for our body? Fix the machine? Treat the patient? Similarly, in a review of the different framings that studies aimed at appraising geoengineering (technically or socially) have adopted, Bellamy et al. (2012) found that the two

most popular ways of conceptualising geoengineering were as a climatic emergency, and as a 'plan B' response to insufficient mitigation. Central, therefore, to the way that the topic of geoengineering is filtering into popular discourse, is the idea that the relationship between humans and the natural world has reached crisis point, and that geoengineering may be the only option left (also see Scott, 2012).

It is not difficult to see why 'messing with nature' might play a central role in shaping public perceptions of geoengineering (Hamilton, 2011; Preston, 2012). Several studies have already suggested that concerns about the way in which geoengineering may represent an unprecedented intervention into natural processes (and what the moral consequences of this might be) are one determinant of how people view proposed geoengineering technologies.

In the limited number of countries where research on public perceptions has been conducted, awareness of the term 'geoengineering', and knowledge about what it means is low, and does not appear to have increased over the past five years (Corner et al., 2012). Research has suggested that there may be a positive correlation between concern about climate change and favourability towards geoengineering (Pidgeon et al., 2012), a general tendency to favour CDR approaches over SRM technologies (Ipsos-MORI, 2010), and a relationship between the social, political and moral views that people hold and their views on geoengineering, with those who express more 'individualistic' worldviews more likely to hold positive views about geoengineering (Bellamy and Hulme, 2011; Kahan et al., 2012). People also tend to make a distinction between research and deployment – with both quantitative survey data (Mercer et al., 2011) and qualitative findings (Ipsos-MORI, 2010; Pidgeon et al., 2013) suggesting that people are open to the idea of researching geoengineering, while holding significant reservations about ever deploying it (see also Macnaghten and Szerszynski, 2013).

In a series of structured discussion groups conducted with members of the public in 2010, titled '*Experiment Earth?*' (Ipsos-MORI, 2010), some illuminating insights into what *informed* public opinion on geoengineering may look like were identified (see also Macnaghten and Szerszynski, 2013; Parkhill and Pidgeon, 2011; Pidgeon et al., 2013). Participants raised serious concerns about the safety of SRM technologies, and a strong preference for more conventional, mitigation options over geoengineering techniques tended to be expressed. Of primary interest for the present paper, 'naturalness' (and the extent to which different geoengineering technologies were perceived as 'interfering' in nature) was an important determinant of public perceptions (a finding supported by Macnaghten and Szerszynski, 2013). Certain geoengineering proposals – like the use of biochar, or afforestation – were seen as more natural, and therefore more acceptable, than others (such as the use of stratospheric aerosols to reflect sunlight), tallying with survey data suggesting that messing with nature is a prominent public concern (Carr and Palmer, 2012).

Reflecting on the *Experiment Earth?* findings, however, Corner et al. (2012) cautioned against interpreting too simplistically the idea that some geoengineering technologies were more 'natural' than others, as the framing of the different technologies by the group facilitators may have unintentionally introduced this idea to participants. The analogies used to describe certain technologies alluded very strongly to a 'naturalness', while others did not. For example, chemical vents for capturing carbon dioxide from the air were repeatedly described as 'artificial trees', while the release of sulphur particles into the stratosphere was reported to participants as being 'no different to a volcano'. While these characterisations might be technically accurate, they also provide a powerful framing: that the way to think about these technologies is by analogy to existing 'natural' processes.

In the current paper, we attempt to go beyond the findings of previous geoengineering public engagement research by providing the first in-depth examination of public views about how geoengineering technologies relate to nature, exploring the reasons why 'messing with nature' is such a powerful narrative in public perceptions of geoengineering, and examining the multiple ways in which people conceptualise geoengineering's relationship with the natural world.

3. Methodology

Following a pilot study in Cardiff, four one day deliberative workshops were conducted in four different cities in the UK: Birmingham, Cardiff, Glasgow and Norwich. Deliberative workshops are a form of facilitated group discussion that provide participants with the opportunity to consider an issue in depth, and are widely used in qualitative research exploring public perceptions of emerging areas of science and technology (e.g., Chilvers, 2010; Dietz and Stern, 2008; Corner and Pidgeon, 2012; Davies et al., 2009; Pidgeon et al., 2009, 2013; Rowe et al., 2005; Stilgoe, 2007). Although the current research contained several innovative methodological features, the design was guided by recent deliberative workshops that the authors conducted (Pidgeon et al., 2009, 2013), and took the form of an invited micro-deliberation (that is, deliberation among a relatively small group of invited participants for a relatively limited duration of time), a methodology that European social researchers have successfully experimented with for over 20 years (e.g. Chilvers, 2010; Pidgeon et al., 2013).

Each workshop was attended by 11 participants, ($n = 44$). Participants were recruited through a professional recruitment agency. Criteria used to recruit a spread of participants included gender, age, socio-economic groupings, educational level, ethnicity and geographic location of participants. This approach was designed to ensure that a diverse range of viewpoints would be included in each workshop. Importantly, recruitment was 'topic blind', with the term 'geoengineering' not mentioned during the recruitment process; instead participants were recruited to take part in discussions related to 'societal responses to climate change'. Participants were given a monetary honorarium for their participation.

The workshops were facilitated by the authors and took place over the course of one day. There were several stages to the day including: (1) an overview of climate change involving a presentation by facilitators and a whole group discussion by participants; (2) World Café style small group discussion of responses (i.e. mitigation followed by adaptation followed by geoengineering) to climate change. In this and throughout each of the proceeding stages, participants were encouraged to generate questions, comments and thoughts, to record these on large post-it notes, and to place these post-it notes on a specially designed 'question wall'; (3) whole group reflection and discussion of the question wall allowing the participants to review the questions generated by all of the small groups; (4) poster reading and poster presentation of putative geoengineering technologies (CDR – biological air capture and chemical air capture SRM–stratospheric aerosols and cloud brightening). The posters were described as depicting 'ideas' for technologies, rather than technologies per se, and where artists' impressions were used, we explicitly and repeatedly described them as such. The posters presented information without any steer as to whether the idea might constitute an advantage or a disadvantage; (5) small group discussion using a series of short 'quotes' representing different perspectives (e.g. the idea that engaging in even desk research on geoengineering would mean a slippery slope to deployment) about geoengineering. These quotes were adapted by the research team

from genuine excerpts found in written articles about geoengineering and were designed to flush out any opinions that had not spontaneously emerged throughout the previous sessions; and (6) final whole group reflection of the question wall.

It should be noted that a key stage in the design and preparation of these workshops was an extensive and thorough methodological review of the 'Experiment Earth?' project (Ipsos MORI, 2009), the original recordings of which the research team was granted access to. This permitted us to learn from the 'Experiment Earth?' process, and we subsequently published a methodological critique and review of the project (Corner et al., 2011). One of the key findings in our analysis was that the 'Experiment Earth' facilitators had, unintentionally, frequently presented information about particular geoengineering technologies as being more or less 'natural' (e.g., describing stratospheric aerosol injection as operating in the same way as volcanoes), or geoengineering in general as something to be used in a climatic 'emergency' (Corner et al., 2011). We were extremely mindful in the current research, therefore, to avoid strong framings such as these (until the very last session of the day in which we introduced a range of possible framings, explicitly, and asked participants to critically engage with them).

All of the workshops were, with participants' informed consent, digitally audio and video recorded. Audio recordings were then transcribed by a professional transcription company and anonymised, with original names of participants being replaced with pseudonyms. The transcripts were analysed with a view to identifying the most important themes and issues, with no prior expectations as to what these themes would be. Through an iterative process of reading, thematic coding (guided by existing literature as well as the data themselves), and reflection, a wide range of core themes were identified, including ideas around the governance of geoengineering, the risk of military conflict, perceived links between materialism/consumption and the need for geoengineering, concern over unintended consequences and the individual features of particular technologies.

We do not seek to capture the entirety of the data in the current publication, but rather to focus on one particular concept which emerged from the analysis–'messing with nature' - which was a frequently-invoked, diversely interpreted and semantically rich theme that bridged and linked to many other ideas and issues–despite the fact that it was never introduced to participants (implicitly or explicitly).

4. Results and discussion: messing with nature?

Analysis of the four deliberative workshops revealed a wide range of views and perspectives on both climate change and geoengineering as a response to climate change, which are described in a separate report (currently in preparation by the authors). But one narrative stood out above all others, and also seemed to play an anchoring, organising and bridging role in linking to other key themes: the (contested) idea that geoengineering means 'messing with nature'.

Our analysis of the data was conducted with a view to identifying – through the application of key theoretical ideas about how humans relate to nature – dominant themes and trends that could be interpreted in light of the extensive literature outlined in previous sections of this paper. In every group, the 'messing with nature' theme was raised by participants *unprompted*, (as well as in response to framings introduced by the researchers subsequently), suggesting that this was indeed a key determinant of participants' views and perspectives. As we discuss and analyse our key findings, we have attempted to link the data to the complex existing literature on how humans relate to nature, but also to identify ways in which geoengineering may point to new dimensions in the relationship between humans and nature. Our analysis is divided into five broad themes, all based on a different strand of the central theme of 'messing with nature'.

4.1. Preserving or threatening nature

Does geoengineering represent an unprecedented, or unacceptable interference in nature? This question – or variants of it – underpinned a considerable amount of discourse in all four workshops. As the following analysis makes clear, participants interpreted and explored the relationship between geoengineering and the concept of nature in an extremely wide variety of ways.

Although many scholars contest whether a primordial nature exists independent of society (e.g. FitzSimmons, 1989; Macnaghten and Urry, 1998), our participants' ways of speaking about nature suggests that they (at least in part) conceptualise nature as being distinct from society. This is highlighted throughout all of the analysis themes and most especially through the ways that participants suggested that the appropriate human role in combatting climate change was to work *with* nature rather than *against* it, setting humans apart from nature and casting them as stewards not only for the planet now, but for future generations:

> "Nature really has got its own balance hasn't it? Its only the human input that has created much of this problem, so if you can get nature to do the best it can, I mean use nature. . .the whole idea is to keep nature doing what nature does" (Fiona, Birmingham)

However, there were mixed feelings about whether geoengineering could be considered as a means of working with nature – to restore it – or whether intervening in the climatic system inevitably meant disrupting nature. One participant felt that there was a level of comfort to be derived from geoengineering, in the sense that it suggested a pathway towards stabilising the earth for future generations:

> "You know I might not be around when this lot (the four posters) happens but I'd like to think that there's something in process, something to keep the planet safe for future generations and I think that's how you should be thinking more" (Rebecca, Birmingham).

But other participants saw geoengineering in precisely the opposite way – as a distraction from more 'natural' ways of responding to climate change:

> "The object is not to create damage, that's surely, we want to reduce the damage we're doing to the planet, you know, and the scientists should be looking at a kind of natural way of doing it, a better way of using say, the sun, you know, the resources that will not cause any knock-on damage in the future" (George, Glasgow).

These divergent views about geoengineering's status in relation to nature–either as a means of 'preserving' nature, or as a threat to it – underscore the socially constructed character of 'nature' (Castree and Braun, 2001), but also demonstrate the complexity of the concept of geoengineering. Faced with the very same prospect (intervention in the Earth's climate), different participants reached very different conclusions about whether this represented a help or a hindrance to natural systems. In contrast to the role that perceived naturalness has played in views about GM crops, or animal cloning (where violations of the natural order are unequivocally considered to be negative by those who raise this as a concern–see, e.g., Sjöberg, 2004; Marris, 2001), geoengineering's relationship (or at least, its perceived relationship) to the natural order seems more subtle.

4.2. Sustainable nature

A commonly held concern was that however society responded to climate change, it had to be based on developing a level of security for future generations, with participants frequently referring to their faith in younger generations to respond more pro-actively than they had. However, the view that geoengineering would necessarily make the future safer was highly contested. Here, the issue of fiddling with natural systems played a key role, with a cautionary narrative playing out in several of the workshops centring on the suggestion that messing with nature meant storing up problems for future generations. Interestingly–given that CDR techniques have been found to be more popular than SRM technologies (e.g., Spence et al., 2010)–the prospect of storing carbon dioxide under ground seemed to be the most common trigger for concerns about the impact of geoengineering on future generations:

> "...you're messing with nature basically, do people know what are the long term effects? Because if there's still carbon underground you may be storing up problems for future generations" (Robert, Glasgow)

In fact, as well as expressing an interest in the welfare of future generations, many participants felt strongly that we should learn lessons from the past, particularly with regard to previous attempts to alter natural systems. Typically, the example people used to illustrate this was deforestation:

> "You're talking about changing their nature aren't you? You're changing nature on deforestation...Its not about money, carbon, it's the whole concept of nature. You're eradicating endless species of plants, potentially animals..." (Graham, Birmingham)

Concerns like these seem to speak directly to McKibben's suggestion (2003) that our level of influence over that natural world has reached such a degree that it has begun to shift the very idea of what 'nature' means. On several occasions, deforestation was identified as an example of irrevocably changing a natural process and as a lesson in the sorts of unintended consequences that experimentation with natural systems could bring:

> "Because they tore down the rain forests and look at the pressures we've got with that now. You know, we've learnt from that so we've got to learn from the mistakes we've made before..." (Mel, Glasgow)

4.3. Nature bites back

The notion of unexpected consequences was one of the most popular topics of discussion in all four workshops. Frequently this bridged directly to concerns about interfering with nature. Several illuminating metaphors and analogies were utilised by participants to explain their concerns about the unanticipated consequences of geoengineering that could prove difficult to control. For example, one participant expressed reservations about rushing into a situation where we were committed to long term natural effects:

> "We're going to get Mother Nature here, so we don't, its not like flicking a switch, so that's why we need to take it easy, you know, slowly to see what the side effects are" (Glasgow)

The same participant then followed up this general point with a metaphor about Frankenstein's monster, and the temptation to abuse the control that geoengineering might one day provide:

> "It's a bit like Frankenstein's monster, if you could control climates to that extent they'd be saying 'Right I'm going on my holidays to the Bahamas, I never want it to rain there'" (Mel, Glasgow)

Analogies like these intimate the possibility that nature might 'bite back' and like Frankenstein's monster, take revenge if provoked. Such a characterisation is a classic literary narrative, with Frankenstein's monster one of many iconic examples of the dangers of messing with nature in folklore and popular fiction (Schelde, 1993; see also Hansen, 2006). Analogies are used frequently by those particularly concerned by developments like GMOs, nanotechnologies and now geoengineering. Indeed, in contestation about GMOs, those against would often refer to GMOs as 'Frankenfoods'. Schurman (2004) argued that such metaphors were used successfully to resist powerful commercial entities' attempts to make GMOs commercially viable in Western Europe.

Participants also found non-fictional analogies for the potential of geoengineering to bring about unanticipated consequences – despite the reassurances of the scientific and political community. Here, it is clear that previous experience of promissory or even hyperbolic narratives around science and technology have led to a certain degree of cynicism around the claims made by scientists about new technologies:

> "Look what scientists have done with the rabbits; myxomatosis. I mean if they'd have done that on a small scale then we wouldn't have the problem we've got today with rabbits. Here we are what, I don't know, 60 or 70 years later and still got myxi. You know they said that would be all right, you know 'we'll just cull the rabbit...". (James, Norwich)

Comparisons with both fictional and real examples such as these are a powerful way for participants to express their concerns about how geoengineering may interact with the physical environment. In fact, as the above examples show, the scale and scope of geoengineering proposals seemed to lead several participants to discuss geoengineering technologies in terms of moral lessons – almost fable-like – learnt from the stories of human experience.

4.4. Nature and society (in)balance

One important way in which our participants linked geoengineering and nature was through a perception of geoengineering as representative of a society that is out of synch – or not living in harmony – with nature. In each of the four groups (without prompting), the idea that society had become more materialistic, greedy, selfish or wasteful was raised. Typically, this would be mentioned in the very first conversation about climate change, and would often be accompanied by a cynicism that the citizens of industrialised nations would be willing to address this in order to make their lifestyles more sustainable. However, while the link between mitigation (via lifestyle change) and materialism is clear, what was more surprising was the extent to which deliberating about geoengineering also triggered many comments about the wasteful nature of society.

One participant's first response to geoengineering was that it was only needed because"...(P)eople won't stop being greedy, because people won't stop having cars" (Shona, Norwich).

For some, the fact that geoengineering was even being discussed was an indictment on society's inability to rein in consumption, and by extension, an inability to live harmoniously with natural processes that provided natural boundaries and limits on human consumption and activity. Mirroring the logic of the *Limits to Growth* rhetoric that was considered to have exerted such a formidable influence almost four decades ago (Dryzek, 1997), a consideration of geoengineering seems to trigger – at least for some participants – a rejection of the idea that consumption rates

can continue to grow indefinitely, facilitated by a geoengineered climate.

One interesting interpretation of the question of whether geoengineering represented an unjustified interference in natural systems came from a participant in Cardiff, who suggested that worrying about messing with nature sounded like a quasi-religious perspective. For this participant – who described concerns about fiddling with nature as naïve, uninformed, archaic and nonsensical – the idea that there was a natural order, which humans shouldn't interfere with, was not credible:

> "Because when you're talking about either a natural or a manmade phenomenon, the sort of, the natural way of things happening could be construed to be its because of God's will. That's not my view, but that's what I was expecting. I find it refreshing that it hasn't come in, to be honest." (Martyn, Cardiff)

The equation of naturalness to the 'natural order' of a world controlled by God, rather than humans, underscores the complexity of the naturalness concept: it can signify both the physical environment (something amenable to scientific enquiry and testing) or a meta-physical entity (something beyond human comprehension or control). Previous research has hinted at an important link between the religious sense of a natural order, and perceptions of biotechnology and nanotechnologies. For example, Scheufele et al. (2008) found that religiosity negatively predicted whether US citizens agreed that nanotechnologies were morally acceptable. Nanotechnology – the manipulation of matter at the molecular level – was seen as violating a normative boundary between the natural (human) and supernatural realm. How those with religious beliefs react to geoengineering as public awareness grows is an interesting question.

Related to Martyn's views that concerns about interfering in nature were archaic or naive, other participants felt that it was hypocritical to claim that messing with nature was bad, when that was exactly what humans had been doing for centuries. On this view, geoengineering is simply an extreme example of how humans have always sought to influence the natural world–at the other end of a spectrum that begins with mundane activities like mowing the lawn, building a house or killing animals for food. Some participants felt that intentionally messing with nature was precisely what was needed in order to redress the balance we had unintentionally disrupted through carbon dioxide (CO_2) emissions:

> "It's going to affect Mother Nature, and we've been doing that for the past 20/30 years and it's when it suits us, and when we accept it, then it's OK, and then it's the next thing, that's messing with. . .we've been doing that from the start and if it's going to be something for the benefit, and all this, for the country, you know, then it has to be done" (Mike, Glasgow)

In this regard, the perceived relationship between geoengineering and the natural order seems more subtle than that observed for other areas of emerging technologies, where discussion about interfering with nature has also been common. Davies and Macnaghten (2010) identified messing with nature as a narrative in debates about nanotechnologies that implied "...orders and boundaries that should – generally – be left alone...being dangerously messed with, blurred and transformed..." (p. 147). Whilst some participants in our workshops held this view about geoengineering, others like Mike, challenged it, arguing that it was hypocritical to fret about the violation of natural boundaries in the context of geoengineering, when so many other human activities were predicated on precisely this process.

Other participants suggested that geoengineering could be thought of as "giving nature a helping hand" *(Helen, Cardiff)*, or as "reversing the messing that we've already done" *(Rose, Norwich)*. One individual argued that geoengineering might more accurately be described as *fixing* the climate–undoing the damage humans have so far caused:

> "We've messed with nature: we put stuff up there. So it's our responsibility to get it back, to help nature to repair itself" (Martyn, Cardiff)

However for some participants what distinguished geoengineering from other forms of human intervention was not necessarily the blurring of boundaries, but the intentionality behind it:

> "And what we said earlier on (to) unintentionally mess with Mother Nature, I think it's a whole different ball game than messing with it intentionally" (Robert, Glasgow)

Participants' concerns about intentionality map directly onto philosophical commentary (e.g., Jamieson, 1996) that identifies intentionality as one of the key features that demarcates geoengineering from other (unintended) interventions in the climate system. And as several commentators have observed (e.g., Stilgoe, 2011), the motivations of scientists are likely to matter to members of the public in the context of geoengineering technologies (see also Parkhill et al., 2013). While volcanic eruptions may have 'accidentally' trialled the sorts of particles that stratospheric aerosol injection might one day utilise, the fact that solar radiation means actively – rather than inadvertently – managing the climate is likely to prove important in determining public views on the subject.

4.5. Regenesis of nature

Earlier, we argued certain geoengineering technologies had been (unintentionally) given a strong framing of naturalness in previous public engagement exercises (Corner et al., 2011). However, when this frame was not provided – as in the current research – participants views on what did and did not constitute a 'natural' form of geoengineering differed. Although some echoed the views obtained in *Experiment Earth?* (that sequestering carbon using biochar was more natural than spraying chemicals into the stratosphere), others rejected the idea that even SRM technologies constituted 'messing with nature' when compared to other technologies like genetic modification and 'cloning':

> "...messing with nature is like cloning or something...whereas going out and putting droplets in the air to increase reflect...that's...its not that same...even though its, its artificial: but nature has a surface in the air. It doesn't have a sheep that's identical to another sheep." (Lisa, Cardiff)

This is an interesting twist on the more dominant view that geoengineering represents an unacceptable interference with nature – here, SRM geoengineering is construed as relatively compatible with natural processes because it at least operates within pre-existing natural systems. Comments like these suggest that although geoengineering shares certain characteristics with other emerging and contested technologies, there may also be ways in which the prospect of controlling the climate is unique.

Although the idea of messing with nature was most prominent in discussions about geoengineering, the structure of the workshop – with a design that 'funnelled' discussion from climate change, through responses to climate change, and finally to geoengineering as one possible societal response – meant that many of the points made in relation to geoengineering had been touched on earlier in the day. For example, Lorna from Birmingham responded quite sceptically to adaptation as a response to climate change, commenting:

> "You can't defy nature at the end of the day can you?[...] the Earth is self-cleansing and whatever you do isn't going to help".

Talking about adaptation also triggered a similar response from another participant:

> "When I see all this I just think of the fact, you know, the magnitude of nature on man and we can put these steps in place but it makes me feel quite small and vulnerable because if they're putting those things in place, and I'm sure that's probably not enough, you know, in generations' time this won't be the case, I think it was going to be on a far greater scale and I just think that we. . .you can never overcome nature in as far as it's more powerful than we are. . ." (Eloise, Norwich)

Another participant in the group agreed that the Earth 'knows' it has a problem and that it might adjust for this by causing a major extinction event (as they suggested had happened in prehistoric times). This kind of view – representing an almost fatalistic conception of the all-powerfulness of nature – was widely shared among participants across all four groups, to a greater or lesser degree. This meant that while most people saw the benefit of trying to prevent dangerous climate change, with some even viewing it as a moral imperative, there was a significant amount of cynicism underpinning these views, and a belief that nature would 'take its course':

> Alison: I do believe the earth has got its own methods of. . .I see man as almost, I know it sounds awful, like a disease on the earth, now that sounds awful really but we are like a disease, we're increasing, increasing, increasing and we're using, using, using and it's almost like a. . .
>
> Ian: Like a rash.
>
> Tony: Like a cancer.
>
> Alison: . . .like a rash that's it, all over the earth and we're taking, taking but I do. . .there's something deep inside of me which I've got no logic for that the earth will actually. . .
>
> Heather: Cleanse itself.
>
> Glenda: . . .do something that will actually. . .it will try and balance that out, it always wins. It always wins somehow, you know.
>
> Ian: That's Mother Nature.
>
> (Birmingham)

5. Conclusion

It is well known that perceived naturalness makes technologies more or less acceptable to people (Pidgeon et al., 2012; Sjöberg, 2000, 2004; Slovic, 2000), so it is perhaps not surprising that 'nature' played a central role in the way that the participants in the current study deliberated about geoengineering, and its social and ethical consequences. In the current paper, however, we have documented a more subtle set of discourses than the dichotomous proposition that nature is good and therefore messing with it must be bad. Almost every aspect of the relationship between geoengineering and nature was contested to some degree: for every individual who considered control of the climate to represent a dangerous and ill-conceived intervention, there was another who viewed climatic control as something unavoidably necessary, or not qualitatively different to other, more mundane human-nature interactions like farming. Hansen (2006) has suggested that invoking 'nature' seems to "inoculate against criticism or further scrutiny and to invest partisan arguments and interests with moral or universal authority and legitimacy" (Hansen, 2006, p. 813). With regards to our participants' discourse, this also seems to be true, as those with positive or negative perceptions of geoengineering invoked conceptualisations of nature that matched their perspectives.

Although there was almost universal acknowledgement that geoengineering meant that natural systems would be interfered with, there was no consensus about whether this was a good or bad thing. Perhaps this is because the context for geoengineering – its justification in the first place – is different to that of most emerging technologies. The dominant narrative surrounding geoengineering–that it may be a necessary 'Plan B', in case our other option fails and we are faced with a climatic emergency – has a great deal more urgency than the dominant narratives around nanotechnologies, or even agricultural biotechnologies. Clearly, there are proposed benefits to nanotechnologies or GM crops, and potentially transformative applications to social problems like the manufacturing of cheap, nutritious food. But there is nothing analogous to the 'climate emergency' driving the development of nanotechnologies or GM crops: they are not, for the most part, framed in the same way that geoengineering is (although proponents of GM sometimes claim that it would solve or drastically reduce world hunger).

All of this suggests that the framing of geoengineering will play a critical role in the way it is perceived, and how the public view it in relation to 'nature' (see Bellamy et al., 2012). As Corner et al. (2011) have argued, framing effects can have a powerful impact on public perceptions of geoengineering. Presenting geoengineering as a possible response to a climatic emergency is problematic, especially if linked to the need to conduct research at an early stage, as it provides a very strong framing of necessity, which could artificially enhance the acceptability of conducting research into these technologies (for more discussion of the ethical implications of framing SRM technologies, see Scott, 2012).

A related point that emerged from our findings is that when we *avoided* describing particular geoengineering technologies using analogies to natural processes, there was no consensus about whether any one particular geoengineering approach was more or less 'natural'. This suggests that the perceived naturalness of geoengineering technologies discussed in previous studies (e.g., Ipsos-MORI, 2010) may have more to do with the way in which different technologies were framed and described, than their actual physical characteristics (see also Corner et al., 2011).

As many scholars have argued, most new technological innovations are considered 'artificial' at first (and subsequently become naturalised – see, e.g., discussion in Macnaghten and Urry, 1998). According to this argument, there is no *categorical* difference between the invention of small-holder agriculture (now an iconic representation of 'natural' activity) and modern innovations like cloning. But just because historical and sociological analyses reveal that the concept of nature is not static, this does not mean that there is no such thing as the concept of 'nature' from a psychological perspective (see, e.g., De Groot and Steg, 2008). It is a temporally dynamic category, certainly, and one that has fuzzy and contested boundaries. But, as dozens of studies in cognitive science and psychology demonstrate, this does not prevent a category from possessing powerful psychological appeal (e.g., Osherson et al., 1990).

For the participants in our study, the contested concept of nature certainly did seem to possess psychological appeal, and exerted an impact on multiple discourses, as we have described above. As the dynamic conceptual window of 'nature' moves to incorporate and exclude new technological developments and human artefacts, so novel questions are raised. The prospect of geoengineering may not be qualitatively different from the unintentional climatic changes produced by human activity since the industrial revolution. But from the perspective of our

participants, it is certainly different in scale and in scope. Concerns about the capacity of human technologies to interfere with nature may be in some senses unremarkable, but the specific issues that geoengineering raises – the physical and social implications of taking global control of the climatic system – are not. In the same way, therefore, that the possibility of cloning raises novel questions about what it means for something to be human, so the prospect of geoengineering suggests new imaginations of the way that humans relate to the natural world.

One unexpected aspect of the debates about geoengineering and nature was the particular salience of concerns about the increasing materialism of modern society. Perhaps, they represent a deeper expression of concern about the continuation of an industrial project that is now known to have had a significantly negative impact on many aspects of the 'natural' environment. Geoengineering does nothing to address unsustainable patterns of resource consumption: SRM approaches do not even reduce levels of CO_2. Concerns about the un-naturalness of geoengineering may in fact be symbolic of a deeper concern regarding whether geoengineering is a sustainable (in the broadest sense of the word) solution to climate change. If the promise of geoengineering detracts attention away from establishing more sustainable consumption and production patterns, then it could be seen as antithetical to valuing nature.

The wide variety of ways in which people in our workshops conceptualised and debated the relationship between geoengineering and the natural world suggests that this will be a key factor determining public views on the topic as awareness of it grows. Geoengineering – the prospect of control over the global thermostat – may usher in new ways to think about nature. As Preston (2012) puts it:

> "(Nature) has served as a canvas against which humans have searched for, and found, meaning in their lives...(T)aking control of this background context of our lives would be psychologically challenging due to the immense burden it would impose on us. There would be no place on earth – or under the sky – where anxiety-producing questions such as 'Are we succeeding?' could be avoided." (Preston, 2012, p. 198)

If – as many scientists now claim – we have entered the anthropocene, then what impact will this have on public perspectives on the appropriate human role in relation to the natural world? The popular science writer Mark Lynas offers one answer in his provocatively titled book *The God Species* (2011). Lynas argues that as we are now equipped with the knowledge of planetary boundaries which cannot safely be transgressed, we are under an obligation to 'play God' and stay within them. An opposing view is offered by the philosopher Clive Hamilton (2010), who argues that our increasingly sophisticated scientific understanding of the Earth and its resource limitations behoves us to withdraw from our dominant position with regards to nature. These two opposing views suggest that humans have either an obligation to respect, or a mandate to pro-actively manage planetary boundaries. But if the concept of the anthropocene is to be taken seriously, it suggests that preserving nature may increasingly become indistinguishable from preserving human civilisation.

Just as a growing awareness of climate change has forced us to reconsider our relationship with the natural systems that sustain us, geoengineering may also remould the way we relate to and value nature. The findings from our deliberative workshops suggest that the perceived relationship between geoengineering and nature is multi-faceted, complex, but also central to understanding how public perceptions of this emerging socio-scientific issue are likely to develop. As knowledge of geoengineering grows, and debates about its social and ethical implications proliferate, it seems likely that the concept of nature–and whether geoengineering represents an unprecedented level of intervention into the natural world–will play an important role in the discourses of publics.

The challenge for researchers conducting public engagement research – and policy-makers faced with the task of incorporating public and stakeholder views into decisions about funding research and developing geoengineering technologies – is to understand the complexity of the relationship between public perceptions of geoengineering and their views on 'nature'. There is a danger here – as happened with GM – that concerns about the potential of geoengineering to 'mess' with nature will simply be dismissed as anti-science, or irrational. Such a development would miss the range of nuanced views presented in the current paper, which show that hidden beneath the seemingly simple colloquium 'messing with nature' are a range of perspectives that collectively offer a sophisticated critique of the implications that geoengineering may have for planet earth, and the roles that human societies play on it.

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