INCUMBENCY, TRUST AND THE MONSANTO EFFECT: STAKEHOLDER DISCOURSES ON GREENHOUSE GAS REMOVAL

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ABSTRACT

This paper explores the factors shaping perceptions on Greenhouse Gas Removal (GGR) amongst a range of informed stakeholders. We find considerable ambivalence about the role of climate targets and incumbent interests; our results suggest that GGR is symbolic of a fundamental debate occurring (not only between separate people, but sometimes within the minds of individuals themselves) over whether technological solutions represent a pragmatic or an unethical strategy. Monsanto, despite having no involvement in GGR, reflects deeper narratives regarding trust, incumbency and 'misaligned' responsibility. Our findings have

significant implications for climate policy, because they suggest that GGR might lack the kind of support which may be necessary for timely, large-scale deployment.

KEYWORDS

Greenhouse gas removal; Negative emissions; Perceptions; Climate change

1 Introduction

The idea of Greenhouse Gas Removal (GGR) has recently risen rapidly up the academic and policy agenda. It has been increasingly suggested that in order to meet ambitious global climate change targets, there is a need to not only reduce the emission of greenhouse gases (GHGs), but to actually remove previously-emitted GHGs from the atmosphere in order to compensate for difficult-to-decarbonise sectors such as heavy industry and aviation (EASAC, 2018). This question has become even more pressing since Article 2 of the Paris Agreement states the aim to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels (United Nations, 2015). The majority of IPCC Integrated Assessment Model (IAM) scenarios require GGRs at significant scale to meet even a 2°C target, a fact which was only recently brought to the fore by increased scrutiny of modelling assumptions following the Paris Agreement (Anderson and Peters, 2016). A diverse range of GGR approaches have been proposed; some of the major ones under consideration are explained in Table 1.

Much existing social science research addresses the topic of 'geoengineering', defined as 'the deliberate, large-scale manipulation of the planetary environment in order to counteract anthropogenic climate change' (Royal Society, 2009:1). This field generally distinguishes between Solar Radiation Management (SRM) measures which would alter the Earth's albedo, and GGR measures which aim to remove GHGs from the atmosphere. The majority of existing social science research on geoengineering focuses on SRM (Cummings et al., 2017), but there is a fast-growing body of technical work on GGR, and the post-Paris period sparked several papers questioning the assumptions of large-scale GGR in many policy-relevant climate models (cf. Anderson and Peters, 2016; Larkin et al., 2017; Vaughan and Gough, 2016). The literature also identifies ethical concerns which means that deploying GGR at scale to meet emissions targets is not a foregone conclusion. Preston (2013) reviews 13 topics of ethical concern

relating to GGR and SRM under four temporal spaces (pre-research, R&D, implementation and post-implementation), focusing particularly on the idea of 'moral permissibility' of intentionally altering the climate. A number of papers discuss various other ethical issues, including concerns about the justice implications of GGR for vulnerable populations, low-emitting countries and future generations (Hansen et al., 2017; Lawford-Smith and Currie, 2017), concerns about democracy and plurality in decision-making (McLaren, 2016; Porter and Hulme, 2013), and concerns that GGR might reduce support for ambitious emissions reductions (Campbell-Arvai et al., 2017; Markusson et al., 2018). Adelman (2017) argues that, although it is important to distinguish between GGR and SRM, both are risky in terms of the ethics of human rights, for reasons of scientific hubris, cessation concerns, and technological 'fetishism' (i.e. the mistaken belief that technology is the answer to all problems). Yet Preston (2015) argues that GGR is less ethically problematic that SRM because it is 'restorative' as opposed to 'additive': it reduces anthropogenic forcing to levels more consistent with an earlier time. Similarly, much of the scientific literature argues that GGR (unlike SRM) treats the root cause of the problem rather than the 'symptom' (cf. Minx et al., 2018). Yet Cox et al. (2018) show that this characterisation of GGR is entirely dependent on whether the 'cause' of climate change is defined as the GHGs themselves, or the irresponsible burning of fossil fuels.

1.1 Stakeholder discourses on geoengineering, GGR and climate change

Many aspects of climate change are characterised by deep, often irreducible uncertainty or even ignorance**.** This has led to increasing use of 'expert elicitation' methods, which seek to gather the informed opinions of expert stakeholders in a specific knowledge domain to develop systematic knowledge in problems that involve significant uncertainty (Rai, 2013). Such methods have been used extensively in quantitative decision-making processes, including interrogating the role of GGRs in climate models (Vaughan and Gough, 2016). Expert stakeholders are increasingly called upon to inform decision-making processes, therefore it is important to understand their perspectives and discourses, especially in instances of high uncertainty or novelty (Lowe and Lorenzoni, 2007). Importantly, expert perceptions are informed by values and beliefs as well as by scientific information and analysis: topics such as climate change are understood in diverse ways, meaning that 'knowledge' (even that of the most eminent experts) depends on numerous contextual factors including individuals' values and belief structures (Hulme, 2009). One advantage of expert elicitation is that it can help to

understand the factors and underlying discourses which currently shape stakeholders' perceptions, thus illuminating some of the knowledge forms and subjectivities which may feed into decision-making processes.

There is a body of existing work on stakeholder discourses on geoengineering. This tends to fall into two categories – examinations of discourses in the public sphere (for instance, in print media or policy documents), and face-to-face studies using workshops, interviews or online methods. Within the former, Nerlich and Jaspal (2012) conduct a metaphor analysis of framings of geoengineering in news and magazine articles from 1985 to 2010, and find three overarching metaphors – 'the planet is a body', 'the planet is a machine' and 'the planet is a patient/addict'. Similarly, Porter and Hulme (2013) argue that the print media anthropomorphises the earth when discussing geoengineering, particularly in the way that the media doesn't generally distinguish between SRM and GGR. Anshelm and Hansson (2014) also analyse media discourses on geoengineering, comparing an 'advocacy' discourse to a 'critical' one, and finding a fundamental dissensus between the two; this relates to the different ways in which the discourses present views on social change, knowledge, and humanity's ability to control nature. Finally, McLaren (2016) conducts secondary analysis of a corpus of media content analyses (including those mentioned above), finding three explicit 'master framings' – technological optimism, political realism, and catastrophe avoidance. Interestingly, he also finds that justice is notable by its absence in these framings, with related concepts such as equity, fairness and distribution receiving barely any mentions; thus he argues that the geoengineering media discourse has deliberately 'framed out' justice, particularly in the way in which geoengineering is positioned as 'essential' in the face of unmitigated climate change.

A slightly separate body of work elicits stakeholder opinions on geoengineering using face-to-face methods. Corner et al. (2012) reviewed the existing research on stakeholder discourses, with the goal of illuminating factors which may influence public attitudes, and found a wide range of overlapping and conflicting views within a rather limited literature. Part of the aim of this paper is to explore the reasons *why* these views might be overlapping and conflicting. Cairns and Stirling (2014) use Q-methodology to analyse geoengineering as a 'subjective discursive construct', finding four dominant framings and an apparent polarisation of the discussion; yet within the alternative framings proposed, they find that a more nuanced picture

emerged, with the ambiguity of the term 'geoengineering' being used to provide flexibility for diverse interests. Bellamy et al. (2013) conduct a large multi-criteria mapping study, wherein experts (and publics, in a parallel series of workshops) drew up a set of criteria by which to judge geoengineering proposals, comparing a number of specific geoengineering options with alternative mitigation options. In this way, they suggest 'opening up' to a wider range of criteria and perspectives; this aim is reflected in our methodology (see section 2). Finally, Gannon and Hulme (2018) also use Q-methodology, in one of the only existing studies on a specific GGR technique, studying communities affected by a highly controversial ocean fertilisation project. Perspectives were strongly geographically rooted, yet also connected to wider cultural meanings and discourses regarding human values of, and responsibilities toward, nature. In this way, their participants' discourses 'reflect(ed) the contested philosophical underpinnings of wider environmental management and restoration debates' (p.14). It is worth pointing out the particularities of ocean fertilisation, because its deployment takes place in open oceans and therefore unlike most GGRs its effects are territorially unbounded. Yet the polarised discourses around mankind's relationship with the natural world may still be relevant for thinking about more spatially constrained GGRs.

Much previous research on stakeholder discourses examines 'geoengineering' as an umbrella term. Yet this term is broad and ambiguous, encompassing as it does a huge diversity of approaches and concepts with vastly different implications. For these reasons, Jamieson argues that geoengineering 'does not mark a specific category of response to climate change but simply alerts us to the fact that the approach under discussion is viewed by the speaker as novel, weird, exotic, unfamiliar, or untested' (2013: 529). There is increasing recognition that the issues faced by GGR may in fact be quite different from those faced by SRM and that therefore the two should be disentangled (Cox et al., 2018; Heyward, 2013). Different approaches may also entail different forms of sociotechnical governance: ocean fertilisation provides one example of this, deployment being prohibited under international law because of the unbounded and unpredictable nature of its effects. Therefore there is value in focusing the enquiry by looking at discourses on a set of specific GGR proposals.

[INSERT TABLE 1 AROUND HERE]

2 Methods

This study forms the initial part of a larger, ongoing project on the perceptions of various publics on GGR, with a particular focus on three novel 'engineered' GGRs envisaged for deployment at significant scale: Direct Air Capture, Enhanced Rock Weathering, and Bioenergy with Carbon Capture and Storage (BECCS). We focus on these three because, at present, these appear to be the three with the greatest long-term CO_2 sequestration potential (Minx et al., 2018: Fig. 6), and thus represent important considerations for decision-makers. For this part of the project, we conducted semi-structured interviews with seventeen informed stakeholders, with the aim of exploring what factors and underlying discourses currently shape their perceptions. Appraisals of technically-advanced climate strategies can suffer from a tendency to 'close down' around narrow problem definitions (e.g. Bellamy et al., 2013); we aim to overcome this by setting up a semi-structured format in which the interviewee is largely allowed to determine the direction of the conversation, thereby opening up to a wider diversity of framings. As a consequence, the results should not be considered to be 'representative' of the full opinions of any individual participant or the body of participants as a whole, but rather to give more in-depth insight into some of the more complex and nuanced aspects of this topic. Despite focusing initially on particular GGR proposals, the semi-structured methodology meant that participants often volunteered their own understandings of 'GGR', for instance by discussing other proposals or by talking more generally about the concept of removing GHGs from the atmosphere.

For brevity, we henceforth refer to our participants as 'experts'. However, it is worth noting that terms such as 'experts' and 'informed stakeholders' are complex, and there is no agreed definition of what constitutes an 'expert' (Lowe and Lorenzoni, 2007). Expertise takes many forms, and some of our participants were selected for their broader knowledge of related fields as opposed to specific expertise on the any of the three GGR proposals. It's also important to avoid fetishising 'expert' knowledge, which may not be any more valid or insightful than that of people approaching the topic of GGR for the very first time (Pidgeon et al., 2017). We therefore conceptualise our 'experts' more as a representation of a particular type of public (or rather, several types, considering their range of expertise), who we thought would have some interesting *pre-existing* opinions on GGR. Later in the project, the results of this study will be used for triangulation with results from workshops with lay publics, wherein we expect few

pre-existing opinions.

The selection of interviewees was designed to elicit a broad range of expertise. We first identified a set of five relevant sectors which we thought would give us a range of perspectives: academia (physical sciences, engineering), academia (social sciences, law), policy and regulation, NGOs, and industrial/private sector. For confidentiality, we have assigned random alphabetical aliases, which do not correspond with any characteristics of the participants. Previous work has shown that the sector in which people work has an influence on their perspectives (Allison, 1969), thus a sectoral approach is one way of targeting a broader spectrum of views. Within these sectors and specialisms, our respondents were selected on the basis of purposive sampling, wherein we first contacted people who we were aware might have some interesting pre-existing opinions. In some cases, we failed to attract a response from the desired individual; in these cases, we used snowball sampling by asking participants to suggest additional people. This combination of purposive and snowball sampling is suitable for instances where the researchers have knowledge of the individuals working within the field, and for studies which aim toward depth and nuance rather than statistical representativeness (Tansey, 2007). Table 2 gives the sector and subject area of each of our participants; for confidentiality, we avoid providing identifying information, and for the results section we have assigned random alphabetical aliases which do not correspond with any characteristics of the participants. The table shows that the majority of our interviewees were academics; this is partly due to a higher rate of response, and partly a reflection of the early stage of GGR development, which means that there are relatively few individuals in other sectors who we felt might have some interesting pre-existing opinions. The people we interviewed were all from the UK and US, although they all work for international organisations or conduct international research. The topic of GGR has a global aspect, because many research efforts stem from the context of global science/policy on climate change, and our participants' expertise was generally global enough that informed discussion was had without deference to geographical context. That said, practices of GGR and their discourses are geographically rooted and tend to be embedded in local context (cf. Gannon and Hulme, 2018; Minx et al., 2018), therefore it is important to take this into account when interpreting our results. In particular, discussions on policy and governance were primarily rooted in the US/UK/Western context.

The interview transcripts were analysed using recognised methods for thematic coding analysis (cf. Braun and Clarke, 2006), using N-Vivo software. We began by listening carefully through the interview recordings many times, to become familiar with the data and to inductively draw out key 'themes' which were prevalent in the interviews. In the tradition of narrative analysis, our focus was very much on the *content* of what was said (as opposed to, say, a discourse analysis where the focus is on *how* it is said), following methods for upstream elicitation described by Macnaghten and Myers (2004). In this paper, we focus on two themes which emerged consistently as the focus of interview discussions – 'risk' and 'responsibility'. We also look at the 'role of the public', a theme which was deliberately introduced via direct questioning from us, for later triangulation with the results from our non-expert study. The following section addresses each of these in turn, presenting what was said by our participants in a descriptive manner. Section 4 then analyses the deeper content of these responses, looking at *why* our participants might have responded in this way, and what this might tell us about deeper narratives on novel GGRs.

[INSERT TABLE 2 AROUND HERE]

3 Results

3.1 Risk

'Risks' or 'concerns' around GGRs emerged as one of the central themes of our coding analysis; yet one of the striking things was the sheer diversity of risks mentioned, and the diversity of conceptual approaches used to discuss various risks. For every new interviewee we spoke to, a different range of concerns emerged; importantly, this was not necessarily aligned with people's disciplines. For example, some of the participants with expertise in physics or modelling showed themselves to be interested in (and adept at) discussing social and ethical issues. Broadly, it is possible to differentiate between three types of risk: physical/environmental (e.g. land-use requirements, ecosystem impacts), techno-economic (e.g. high capital costs, lack of technology readiness) and social (e.g. acceptability, equity, health). For Direct Air Capture and Enhanced Weathering, techno-economic and environmental risks were overwhelmingly mentioned first and most explicitly, whereas social risks were mentioned much later in the conversation (if at all) and more implicitly. However, when

discussing BECCS, no such pattern emerged, with social risks mentioned just as frequently as environmental ones. We hypothesise that this could be because of the relative state of knowledge about unintended social consequences, many of which have become apparent with the development of a large-scale biomass industry. Unintended social consequences are notoriously difficult to envisage, therefore perhaps social risks for more novel GGRs are under-discussed precisely because we haven't yet experienced them. For biomass on the other hand, it has become apparent that the social and physical risks are actually tightly interconnected: for example, impacts on ecosystem *services* constitute both an environmental and a social risk.

One of the most common 'risk' topics discussed was the concern that investing in, or even believing in, the prospect of negative emissions at scale might reduce incentives to pursue steep emissions reductions – termed 'mitigation deterrence' by the GGR research team at Lancaster University (cf. Markusson et al., 2018). The risk of mitigation deterrence was portrayed not just as a question of policy – it was also a question of narratives, or in the words of one participant, 'the stories we tell ourselves':

> *So, a negative emission technology operating out of a field in Bedfordshire justifies the continued exploitation of the North Sea and fracking, because the stories we tell ourselves, 'It's all okay because we've now got this way of dealing with the emissions as a consequence' (participant O).*

Unsurprisingly, there was generally consensus that conventional mitigation (in the sense of low-carbon supply or energy demand reduction) needs to come first and foremost, and that GGR should be thought of as 'a potential addition' and 'in no way a substitute', with 'a larger role for demand reduction and more renewables' (participants B & P).[1] Yet many people also recommended GGR for maintaining a diverse portfolio of measures, whilst acknowledging that tough choices must be made regarding what this portfolio might look like and the trade-offs therein. In the words of participant G: *'I don't think any one of the proposed solutions so far is a magic bullet. We are looking at a blend of different solutions. I just think, we need to get on with it.'* The majority of participants rejected the idea of a binary choice between mitigation and GGR, whilst at the same time warning of mitigation deterrence and opportunity cost; clearly, a

[1] It is worth reiterating that the mitigation scenarios used to inform policy-makers do *not* portray GGR as an 'addition'; rather, in the vast majority of models GGR is critical to meet a 2°C target.

tough task remains in deciding what sort of portfolio of measures should exist, and who gets to decide what this should look like.

It would be remiss to discuss risk without also discussing benefit, wherein the most commonly mentioned benefit was the possibility that GGR will be necessary to avoid dangerous climate change. This topic in many ways illustrates the diversity of responses: opinions ranged from 'GGRs are vital' to 'GGRs are dangerous' and everything in between. This remark by participant C is a good example of the 'necessity' discourse:

> *But we have absolutely no chance of getting there [to global net zero emissions] without carbon dioxide removal, there's no question about that. If you run the models on the back of an envelope, you don't need a computer, we're just not ever going to get there.*

This is tightly connected to a prevalent discourse of urgency, evident in assertions that 'we just need to get on with it'. Yet many participants argued that the modelling assumptions which led us to these conclusions need to be examined critically. The assumption that GGR will be 'necessary' to avoid 'dangerous' climate change is clearly a strongly framed statement which is somewhat reliant on trust in the IAM scenarios – trust which may be wavering amongst the scientific community due to concerns over the transparency of GGR assumptions in the models. This resulted in a complex and sometimes ambivalent discourse emerging regarding deference to climate targets and the role of experts and global climate institutions. Several participants critiqued the process of target setting and the emergence of the 'necessity' discourse as having taken place within a very top-down, undemocratic system; yet international agreements, and the science to back them up, may be required to deal with the problem of climate change. This remark by participant L illustrates the two sides of this discourse, in which some participants fell squarely in the middle:

> *So, I'm a degree sceptical about, in the bigger picture, these targets take on too big a role in shaping and guiding and directing, not just discursively, but actual real investments. Having said that, this is the political process we're in and we've been in it for 30 years around climate change, and international negotiations and target setting is not going to disappear anytime soon.*

3.2 Responsibility

Although not always mentioned explicitly, responsibility was a prevalent underlying topic during these interviews. Responsibility can of course mean many things: responsibility for emissions reductions; responsibility to develop and pay for GGRs; responsibility to govern and safeguard against risks of various kinds; responsibility to pursue equity, justice and democracy. Many of the semi-structured discussions drifted quickly onto the topic of 'who decides' on a desirable emissions target and how best to go about achieving it, a clear corollary to the discussion about deference to climate targets. Very frequently, points were made regarding how 'we' or 'society' needs to make decisions, as illustrated by this quote from participant D:

> *And so, we have to make some hard choices at this point, and we need some tools in determining what those trade-offs are and how we as a society determine how we make those trade-offs.*

This then raises questions regarding the exact meaning of words such as 'we' and 'society'. Several participants mentioned the topic of democracy and collective decision-making, yet sometimes then went on to focus mainly on the role of experts and policy-makers; in fact, for most participants, the subtext of 'responsibility' seemed to lie mostly with experts, policy-makers and high-emitting industries. Yet alongside this, the interviews demonstrated a rather fundamental lack of trust in policy-making and private sector institutions. For example, participant B said, '*I think the answer has to lie with the politicians, which I wouldn't like to leave too many decisions to them.'* Participant N neatly sums up the nuanced way in which this lack of trust is not necessarily based on the untrustworthiness of any particular institution or individual, but rather: *'We're not talking about conspiracies here, we're talking about the way incentives align, the way incentives are reformulated as a result of the co-development of new technologies.'*

Our interviewees were also cautious about the role of researchers and technology developers, voicing wariness about *'advocates who see all the benefits' (P)* and *'passionate scientists who have a very clear bias' (M)*. The private sector was also revealed as a major source of mistrust: *'I think we're all of us now rightly suspicious of the motives of large, multinational corporations' (C).*

Fundamental ambivalence was revealed about the role of the private sector in R&D for GGR, with participants lacking trust in the motives of the private sector and in the objectivity of privately-funded trials. Concerns about the full reporting of negative results were raised by several people, and multiple participants referred to past controversy over private sector involvement – particularly the Monsanto company – in genetically modified (GM) crop development (more on this section 4). Yet simultaneously, participants acknowledged that the resources of the private sector may be required for capital-intensive research and technology development. For example, participant D said: '*I would have some enhanced concerns if this were being driven by a profit motive, while simultaneously acknowledging that that might be the only way that it actually happens'.* Private capital will never have altruistic motives, but at the same time it was argued by many that working with powerful institutions is more pragmatic than working against them. This essentially comes down to a question of whether the ends justify the means: *'Social responsibility versus vested interest is a fine line, perhaps, but there we go' (G).*

A related responsibility theme was the 'polluter pays' principle. By working within incumbent systems, perhaps it is possible to create climate strategies which are paid for by those responsible for the problem in the first place, i.e. the world's highest emitters. Many mentioned the idea of a tax or levy on emissions which could be used to pay for GGR research or incentives. This was popular both for reasons of fairness: '*It'd be quite good to turn the fossil industry around and say 'Now fix the problem you created'. It'd be kind of cool, in a way',* and pragmatism: *'If we get away from fossil fuels but somehow, we don't put everyone out of business … we just turn them round and do something else with it' (both participant H).* Participant K suggested that having GGR options – particularly Direct Air Capture – on the table could actually help to shift the burden of responsibility:

> *Having a technology that could remove CO2 from the atmosphere changes the whole moral situation. At the moment, an emitter of CO2 can say, 'Well, we would clear it up if we could, but there's no technology that can do it, so we can't.' Once there is a technology that can do it, it's no longer, 'We can't do it', it's, 'We don't want to do it.' And that creates a very different moral situation. It enables people to say, 'Well, you should clean it up because you can.'*

However, amongst many of the participants there was also a strong feeling that the incumbent

system will tend to benefit the historical winners. Some participants saw GGR as presenting an 'opt-out' for those responsible for causing the problem in the first place, an issue which is closely connected with the narratives of necessity and mitigation deterrence discussed previously. For example:

> *Governments and politicians and others are signing up to saying, 'We're going to aim to get as close to 1.5˚ as we can or well below 2˚.' And yet, on the same hand, at the same time, knowing full well they're not actually decarbonising their own economies very far (Q).*

It was also pointed out by several participants that perspectives may be very different in the Global South. For example:

> *There's a great deal of scepticism around negative emissions… many of those countries have been at the front end of western countries' dash for biofuels; it's their forests that have been bought up by overseas companies and people driven off, or the oil palm rush, or the rush to produce soya to feed our cattle so we can have massive Big Macs (Q).*

The ethics of international carbon accounting is complex, and often fails to take into account the equity and justice considerations of implementing GGR in developing countries. For example, there was widespread opinion that implementing BECCS at large scale would probably result in some extremely unjust outcomes which would unfairly penalise vulnerable communities for the past or present actions of the world's wealthy and powerful. Participant A said: '*I am saying it's bloody suspicious how often the settings in which these things are best experimented with happen to be the settings where they're least resisted.*'

3.3 The role of the public

At the end of the interviews, the participants were asked directly about their thoughts on the role of the public (or, as stressed by many, the role of various publics) in GGR development and deployment. It is interesting that, despite the prevalence of topics of responsibility and power across almost all participants, the role of non-experts didn't tend to arise until the question was asked explicitly at the end of the interview.

Several participants conceptualised the role of the public in terms of policy and decision-

makers, for example: *'The primary role of the public is to motivate their politicians' (C)* and '*If you're not involving members of the public in this decision, you're missing important evidence upon which to base your decisions' (B).* Similarly, several suggested that the role of the public should be to provide checks and balances to the experts and proponents about whom distrust was voiced previously: '*I think sometimes when we say 'expert', we mean someone who's already got the blinkers' (H)*; this response itself reveals some reflexivity around the role of experts, as this interviewee presumably recognises that they are themselves considered an 'expert'. However, some argued that the role of the public is more fundamental, and should take place earlier in the process, in setting the very framing of the questions around these proposals: '*It's not so much, how should society be involved in this question, it's more, what questions does society want to ask?' (A).* This sentiment was also echoed alongside a mistrust of the kinds of consultation exercises often employed, in which the publics' answers are essentially pre-determined by the nature of the questions being asked. Again, several participants referred to the GM controversy; yet in an interesting echo of that debate, there were plenty of participants at the other end of the spectrum who saw it as important that the public be informed about and consulted on the risks and benefits of technologies which have already been developed. For example:

> *Like any of these production routes, technologies and things like that, you've got to get some level of acceptance… Ultimately consumers, the populace have got to feel assured that what's happening is good… certainly not bad, anyway (E).*

> *…You need to convince the public that there is some value in these bioenergy crops without detracting from food production, from the value of your agricultural lands (I).*

The range of responses we identified here was almost entirely aligned with the continuum of responses discussed in the previous section, regarding the relative 'necessity' of novel GGR proposals. Participants who envisaged a more agenda-setting role for the public tended to be more sceptical, highlighting concerns about justice, democracy, and social and environmental risks. Meanwhile those who envisaged a more consultative role for the public tended to be more advocative of GGR, often envisaging a necessity or even inevitability of the idea. As such,

we found that the responses were not necessarily aligned with people's discipline or area of expertise.

4 Discussion

4.1 Incumbency

As can be seen from the preceding section, much of the underlying discourse is related to perceptions of incumbency. Although there was much diversity in our participants' attitudes to GGR, attitudes seemed to coalesce around whether or not they felt that climate strategies should aim to work within existing incumbent capitalist systems. There is a question here over whether the primary concern is climate change or the fossil fuel industry (or even capitalism itself): currently, these tend to be aligned in climate discourse, but if solutions to climate change actually come from within the industry (for instance by financing GGR through the polluter pays principle) then this discourse becomes contradictory. An interesting corollary to this is in work which has shown that geoengineering solutions may actually be popular with climate sceptics, because geoengineering may align better with 'individualist' and 'hierarchical' worldviews than conventional climate change approaches, which mainly appeal to 'egalitarian' worldviews (Bellamy et al., 2017; Heyward and Rayner, 2014; Kahan et al., 2012). In this way, debates around GGR find similarity with earlier debates on sustainable development and ecological modernisation, with proponents of working within incumbent systems arguing that a sustainable transition is possible by shifting existing industrial society toward a more ecologically-focused mode of production, whereas a 'deep green' discourse argues for radical transformation away from the capitalist focus on economic growth (cf. Dryzek, 1997). Applying this to the new debate on technological solutions to climate change and the role of climate models, Keary argues for an approach that 'would not stake the earth on future technological improvements' (2016: 24).

This is linked to the topic of mitigation deterrence, because GGR is seen by many as a potential opt-out for incumbents to avoid taking difficult decisions or actions on climate change. Within the 'necessity' discourse we identified, radical emissions reductions are seen as being simply too difficult, and thus GGR is needed to avert dangerous climate change. Yet this discourse was critiqued and even rejected by many of our participants, because there is a difference between

a technical and a political challenge: the counter-discourse argues that radical emissions reductions are simply portrayed as being 'too difficult' by incumbent interests who wish to protect the status quo. Importantly, this suggests that Carbon Capture and Storage (CCS) may provide a useful analogue for thinking about GGR risk and responsibility (cf. Markusson et al., 2017a). Experts' perceptions of CCS have been researched in more depth than GGR, and there is some evidence that CCS may experience some of the same social and ethical concerns, such as path dependency and mitigation deterrence (Hansson and Bryngelsson, 2009; Markusson and Haszeldine, 2009). The 'necessity' discourse is also found to be quite strong amongst experts discussing CCS, wherein tackling climate change is seen as simply being too difficult without it (Hansson and Bryngelsson, 2009; Sala and Oltra, 2011). However, we also noticed a major point of departure – depending on the study, experts' perceptions of CCS often focus on barriers to implementation; in other words, whether we *could* implement CCS. The results from our GGR interviews, on the other hand, show a crucial ethical and normative element – whether we *should* implement GGR. This is interesting because many GGR proposals necessarily incorporate CCS technology, thus raising the question of whether there is anything particular about negative emissions (as opposed to emissions reduction) which makes it more ethically problematic. Exploration of the particular characteristics of GGR and CCS shows that ethical differences between them are in fact extremely blurred (Cox et al., 2018). Therefore we suggest that perhaps the very concept of removing GHGs from the atmosphere gives a stronger implication that mankind has failed to adequately challenge unsustainable system dynamics.

In many ways, the ambivalence revealed around certain topics in the preceding section (e.g. the role of climate models, the role of the private sector) is symptomatic of the ambivalence experienced by participants around working within incumbent systems and institutions. Our interviews showed that stakeholders do not necessarily fall into two separate camps, often experiencing ambivalence regarding their own stance. In other words, there is a deep debate occurring – not only between separate people, but sometimes within the minds of individuals themselves – over whether technological solutions represent a pragmatic strategy in the face of incumbent system inertia, or whether they simply fail to adequately address unsustainable patterns of production and consumption. Unlike Gannon and Hulme (2018), whose Q-sort identified a fairly polarised discourse around ocean fertilisation, our interviews revealed that 'advocacy' and 'critical' discourses (cf. Anshelm and Hansson 2014) were frequently present within the same stakeholder. Perspectives are non-binary, and although there may be

outspoken proponents toward each end of the continuum, most of our participants spoke to multiple places on the continuum simultaneously. Cairns and Stirling (2014) find similar nuance, and relate it to the ambiguity of the term 'geoengineering'; yet in our interviews this emerged despite discussing three specific GGRs, suggesting that it may go beyond definitional questions. This debate is connected to the discussion on whether GGR is 'restorative' or 'additive' (Preston, 2015): the suspicion over incumbent systems in many ways reflects a deep unease about the concept of GGR as 'restorative', because net anthropogenic forcing is not really seen as being the 'root cause' of climate change. Yet there is tension here with the mitigation deterrence discourse, which might explain some of the ambivalence. There is widespread agreement (both here and in the surrounding policy and academic literatures) that conventional mitigation options such as renewables must take precedence in order to avoid mitigation deterrence; yet large-scale commercial renewables don't really challenge the incumbent system either. Again, the heightened levels of concern about GGR suggest that the concept of removing GHGs creates a stronger impression of failure to challenge unsustainable system dynamics.

4.2 'The Monsanto effect'

It might seem odd to name a paper after a company which, to our knowledge, has little or no involvement in GGR. Yet the Monsanto company was mentioned unprompted by a surprising number of our participants, and their role in GM crop development may provide an interesting example of the themes of trust and incumbency discussed throughout this paper. The GM controversy provides important lessons for novel technology development, because it acted as an illustration of the importance of extensive upstream public engagement: by the time decision-makers read the results of early engagement work, a major public controversy had erupted with NGOs and some media taking strong anti-GM stances (Grove-White et al., 2000). Monsanto is a major producer of GM crops, and became synonymous with distrust over the crops themselves and the entire incumbent agro-industrial system. We thus hypothesise the existence of a 'Monsanto effect', whereby one company's involvement in an entirely separate debate (in this case, GM food) taps into deeper narratives and becomes so pervasive that it spills over into a new debate (in this case, GGR). This analogy could in theory be generalised to multiple other topics, because this discourse isn't really about Monsanto *per se*. Monsanto simply represents the incumbent system over which there is a lack of trust and a perception of

'misaligned responsibility'; in other words, responsibility for profit motives, rather than for the good of society or the environment.

The interview results were interesting because they revealed a rather fundamental lack of trust in many institutions, particularly in the private sector. This distrust reflects debates in the literature around the role of GGRs – particularly BECCS – in IAM scenarios (Anderson and Peters, 2016; Vaughan and Gough, 2016), a debate which was referred to by many participants. Again, the misgivings revealed something deeper than distrust in the modelling process *per se*; the concern is that the very questions which are being asked in the scientific community are defined by a small group of elites, without participation from those who might be most affected by the outcomes. Keary (2016) argues that models employ technological optimism to show us that sustainability and economic growth are compatible, whilst marginalising discourses which might contradict this. McLaren (2016a) suggests that this type of framing actually benefits GGR over SRM, because GGR may be more compatible with a neoliberal ideology wherein climate change can be tackled using technology, carbon markets and capitalism, whereas SRM represents a far more disruptive challenge to incumbent systems. Thus the 'promise' of GGRs in models permit the idea of continuing with the existing regime without having to change it much (Markusson et al., 2018). As such, the ambivalence revealed by our stakeholders is reflective of discussions in the literature around 'epistemic justice' in climate decision-making: in other words, concern about the way in which society interprets a particular phenomenon or tackles a particular question (Mabon and Shackley, 2015). Thus even if fair procedures are in place, viewpoints may be marginalised by the way an entire societal discourse treats a question or problem. For example, processes of framing and agenda-setting can determine which knowledge (and whose voices) are rendered admissible (Blue, 2015). By increasingly seeking a 'global knowledge consensus' (for instance through deference to global IAMs), climate change discourse allows only the most powerful to determine what forms of knowledge are valid, rather than attending to the diversity of cultures and values which generate a diversity of forms of knowledge (Hulme 2010).

These issues of trust mean that more diverse publics need to be involved in decision-making, not just over when or where a technology is implemented, but over the emerging discourse around that technology and the questions which are asked. Amongst our experts, those who

envisaged a much more active and agenda-setting role for non-experts tended to be more sceptical of GGR, whereas those who outlined a more consultative role tended to be much more advocative of GGR. This has important implications for the way in which GGR support mechanisms are designed and appraised, because advocates of GGR might be less predisposed to get broader peer communities or publics involved (and the literature on public engagement, plus decades of experience, shows us why this might be a mistake [Funtowicz and Ravetz, 1995; Grove-White et al., 2000]). Equally, however, we need to be reflexive about the motives of those sceptical of GGR who propose a broader role for non-experts: it may be that non-experts are seen as a mechanism by which GGR proposals can be slowed or halted, yet in the current absence of empirical research on public perceptions of these proposals, we cannot simply assume that they will play this role.

4.3 Limitations and areas for further research

It was interesting to note the diversity of viewpoints which emerged from our interviewees. However, this was partly a reflection of the broad range of opinions we sought to elicit, and the fact that due to constraints on time and resources, it was only possible to interview seventeen people. Interviewing more might have given us a better idea of the extent of viewpoint diversity and the degree of alignment with people's sectors and disciplines. Furthermore, our purposive/snowball sampling methodology, whilst widely recognised in the literature on expert elicitation, may have biased our findings due to our subjective targeting of participants. Upon reflection of the results, it would also have been useful to interview people from a larger geographical range, including experts from the Global South. Although many of our experts voiced with some authority the views of their global organisations and their partners in Global South areas, their perspectives will still have been rooted in their local or national context and experiences (cf. Gannon and Hulme, 2018).

The interview results were also limited by the time allotted: in recognition of many experts' busy schedules, we aimed to keep the interviews to around one hour, and there was not always time within the hour to discuss individual GGR proposals in much detail. Our methodology deliberately sought to allow interviewees to determine the direction of the conversation, with some focusing more on specific technologies and some discussing the concept more generally. However, more time in particular could have been devoted to probing perspectives on BECCS,

for example exploring in more depth the differences in the types of risk discussed for BECCS as opposed to other GGR proposals (see section 3.1). Nevertheless, several of the results which emerged from our analysis suggested that there may be something rather fundamental about the way in which these three novel GGRs are envisaged and the way in which they interact with incumbent systems, which is useful to explore as a separate discussion from technology-specific risks.

5 Conclusions and recommendations

This paper has contributed to a growing body of research on Greenhouse Gas Removal for climate change mitigation, exploring discourses on three GGR proposals (BECCS, Direct Air Capture, and Enhanced Weathering) with a particular focus on the role of these GGRs in future social and political systems. We conceptualise 'informed stakeholders' as a certain type of public, whose perspectives are shaped by assumptions and subjectivities just like other publics; therefore it is important to engage with informed stakeholders whilst remembering that their knowledge should not necessarily be prioritised over other forms or sources of knowledge. We found considerable diversity amongst our interviewees, with new perspectives emerging with each new person we spoke to, and only partial alignment with their discipline or sector. We suggest that CCS can provide a useful analogue for thinking about GGR risk and responsibility; however, expert perspectives on CCS tend to focus on a techno-economic narrative of whether we *could*, whereas these GGRs seem to raise more ethical and normative narratives of whether we *should.* The underlying discourses of our participants suggested that this may be because the concept of negative emissions gives a stronger implication that mankind has failed to adequately challenge unsustainable system dynamics.

Ambivalence was revealed about the role of the private sector, with participants lacking trust in their motives yet simultaneously acknowledging that their resources may be required. We noticed that the Monsanto company was mentioned by numerous interviewees, despite the fact that they have no current involvement in GGR, because of the way in which they became synonymous with incumbency, distrust and misaligned responsibility during the GM debate. We thus hypothesise the existence of a 'Monsanto effect', whereby an organisation's involvement in a separate debate taps into deeper narratives and becomes so pervasive that it

spills over into an entirely new debate. This effect is illustrative of the way in which perspectives on GGR appeared to be rooted in deep-seated values regarding trust and the role of incumbent systems and interests. GGR appears to be symptomatic of a deep debate, sometimes within the minds of individuals themselves, over whether technological solutions represent a pragmatic strategy in the face of incumbent system inertia, or whether they simply fail to adequately address unsustainable patterns of production and consumption. We thus highlight a particular psychological challenge facing high-tech GGR, in that actors themselves may feel conflicted about its desirability. This has significant implications for climate policy, because it suggests that some novel GGRs might lack the kind of support which may be necessary for timely, large-scale deployment. In other words, GGR appears to be failing to garner support which is broad (from a spectrum of actors including policy-makers, NGOs and intermediaries) and deep (in that it aligns with actors' values).

The topics covered in this paper are essentially about four forms of justice – distributive, restorative, procedural and epistemic. Our participants' ambivalence about the role of the private sector, and their concerns about the impact of GGR on land requirements and communities in the Global South, are questions of distributive justice – who gets the burden and who gets the benefits? Meanwhile the topic of responsibility raises questions of restorative justice – to what extent will those causing the problem be held responsible for dealing with it? The topics of climate targets and the role of the public are questions of procedural justice – who gets to decide whether GGRs are 'necessary'? Each of these topics emerged from the analysis, not as discrete headings, but as a tightly interconnected web of overlapping concerns, rooted in deep-seated values regarding the role of incumbent systems and interests, and in underlying concerns about the degree to which epistemic justice is maintained in current approaches to developing and assessing climate policy. We thus conclude by recommending that greater attention is paid to the role of justice and incumbency in the development and deployment of GGR proposals. It can be difficult to be reflexive about the influence of a powerful incumbent narrative when, to some extent, all experts (including the authors of this paper) exist within it; yet perhaps greater focus on the justice questions raised here can help to provide a counter-balance to the incumbent narrative which speaks of 'necessity'. For example, we agree with some of our participants that there needs to be a measured discussion about the primacy of carbon targets in climate strategy, lest we risk drifting toward solutions which may *create* some of the impacts we're trying to avoid. We also recommend that future work continue to build on

the efforts of previous research (e.g. Bellamy et al., 2013; Bellamy and Lezaun, 2017; Pidgeon et al., 2017) to 'open up' the appraisal of novel technologies to different publics and different framings of the problem definition. Crucially, this requires improving the mechanisms by which diverse perspectives can contribute towards the co-creation of knowledge, decision-making and responsible technology development.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Table 1: Some major GGR proposals. Adapted from Olson (2011).

Method	**Description**	**Tech readiness**	**Concerns**
Afforestation / reforestation	Planting trees or reforesting previously deforested areas	Already widely implemented	• Land-use conflicts between reforestation and agriculture • Carbon stored in vegetation can easily be released by fire, drought or deforestation
Soil Carbon Sequestration (SCS)	Changing land management and farming practices to increase the carbon content of soil	Ready for implementation	• Soils eventually reach saturation • Vulnerable to disturbance (e.g. later land-use changes) • May increase release of other greenhouse gases from soil
Wetland restoration	Restoring or constructing carbon-dense ecosystems such as wetlands, peatlands and coastal ecosystems.	Already being implemented at small scale	• Increased production of non-CO_2 gases such as methane • Relatively limited global sequestration potential • Competition for land
Bioenergy with Carbon Capture and Sequestration (BECCS)	Biomass used as fuel for electricity generation or hydrogen production, with Carbon Capture and Storage (CCS) of the resulting CO_2.	All components ready but not yet being used at scale. CCS deployment experiencing delays.	• Fuel vs. food: incentive for biomass production can reduce the availability and increase the cost of food crops • Environmental impacts of intensive growing • Availability and safety of sequestration sites
Biochar	Agricultural and forestry wastes burned through pyrolysis to produce biochar	Well understood but not yet widely implemented	• Supply of biomass wastes • Long-term impacts of high biochar applications not yet known

	(charcoal), which is sequestered in the soil.	due to lack of pyrolysis facilities.	
Terrestrial Enhanced Weathering (EW)	Rock weathering processes accelerated by finely crushing and spreading rocks. Rocks weather to produce carbonates, which sink into the deep ocean, sequestering the carbon they contain.	Could technically be implemented now, but not economically feasible. Field trial research into ecosystem impacts is ongoing.	• Requires mining, processing and transportation of large quantities of crushed rock, with high energy use and costs • Uncertainties about impacts on soil pH and vegetation • Possible leaching of heavy metals into soils and crops
Direct Air Capture (DAC)	Industrial processes to extract CO_2 from ambient air, with capture and storage (CCS) of the CO_2.	Mainly at laboratory stage. CCS deployment experiencing delays.	• Technically feasible, but not clear if cost effective processes can be developed • Requires large amounts of energy to power the DAC units • Availability and safety of sequestration sites
Ocean Fertilisation	Adding iron, nitrogen or phosphates to ocean water as nutrients to stimulate the growth of phytoplankton that absorb CO_2 during photosynthesis.	Research stage. Deployment prohibited under the London Convention.	• Potential disruption of the ocean carbon system • Not as effective as hoped for removing carbon • Generally viewed as extremely high-risk

Table 2: Details of interviewees

Alias	**Sector**	**Subject area**
A	Academia	Social sciences
B	Academia	Social sciences
C	Academia	Physical sciences
D	Policy / regulation	Law & social science
E	Private sector	Physical sciences
F	Academia	Engineering
G	Academia	Physical sciences
H	Academia / policy	Physical sciences
I	Academia	Physical sciences
J	Academia	Physical sciences
K	Private sector	Policy
L	Academia	Social sciences
M	NGO	Law & policy
N	Academia	Social sciences
O	NGO	Policy
P	Policy / regulation	Policy
Q	NGO	Policy & social science