Global Environmental Change 45 (2017) 194–202

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Public perceptions of geoengineering research governance: An experimental deliberative approach

Rob Bellamy[a,*], Javier Lezaun[a], James Palmer[b]

[a] Institute for Science, Innovation and Society, University of Oxford,64 Banbury Road, Oxford, OX2 6PN, UK
[b] School of Geography and the Environment, University of Oxford,South Parks Road, Oxford, OX1 3QY, UK

ARTICLE INFO

Keywords:
Climate engineering
Controllability
Experimentation
Geoengineering
Governance
Public perceptions

ABSTRACT

Recent attempts to conduct experiments in climate 'geoengineering' have demonstrated the deeply controversial nature of this field of scientific research. Social scientists have begun to explore public perceptions of geoengineering, and have documented a significant degree of concern over the effective governance of research and experimentation in this area. Yet, public perception on what constitutes a legitimate geoengineering experiment and how it should be governed remains under-researched. In this article we report on a series of experimental deliberative workshops with members of the public designed to elicit and explicate diverse understandings of geoengineering experiments and their governance. In contrast to previous methods of invited public deliberation, which privilege egalitarian-consensual models of discourse and decision-making, we test a novel approach that places majoritarian, individualistic, and consensual forms of public deliberation on an equal footing. Our study suggests that the perceived controllability of experimental interventions is central to public views on their acceptability, but that controllability is itself a complex, multifaceted quality, drawing together a set of heterogeneous concerns about the purpose and repercussions of scientific work. The citizens who participated in our workshops employed four criteria to adjudicate the acceptability of geoengineering experiments: (1) the degree of *containment*; (2) the *uncertainty* surrounding experimental outcomes; (3) the *reversibility* of impacts; and (4) the scientific *purity* of the enterprise. We theorize that the public legitimacy of geoengineering experiments depends on variable, context-specific combinations of these criteria, and that technical determinations of the proper 'scale' or 'location' for geoengineering research will be poor predictors of the sorts of public concerns that will be triggered by further experimentation in this area.

1. Introduction

The possibility of carrying out deliberate large-scale interventions in the Earth's climate system has emerged as a controversial addition to the arsenal of options to moderate anthropogenic climate change. These 'geoengineering' or 'climate engineering' proposals comprise variants that seek to remove carbon dioxide from the atmosphere (carbon geoengineering), or to reflect a fraction of sunlight away from the Earth (solar geoengineering). Scientists and engineers have begun to design and conduct experiments to test the technical viability of some of these ideas. Some of these trials rely on familiar technologies (e.g. the production and burial of pyrolyzed biomass, or 'biochar'), unfold in virtual environments (e.g. through computational modelling), or involve ostensibly non-invasive scales of research (e.g. they unfold within a laboratory). The few experiments that have tested new or unfamiliar technologies in the open have, however, attracted a significant degree of public interest and media scrutiny. Notable cases include the proposed testbed for a stratospheric aerosol delivery mechanism included in the UK Stratospheric Particle Injection for Climate Engineering (SPICE) project (Stilgoe, 2015), and the ocean iron fertilisation release carried out by the Haida Salmon Restoration Corporation in the North Pacific (Tollefson, 2012).

The obvious public interest in the design and conduct of geoengineering experiments has led to calls for broader civil society consultation on the definition of acceptable and unacceptable geoengineering research. The 2010 Asilomar International Conference on Climate Intervention Technologies, for instance, concluded with a recommendation for "public participation and consultation in research planning and oversight." Similarly, the recent reports issued by the U.S. National Academies of Science on the research that ought to underpin different forms of "climate intervention" argued that "open conversations about the governance of such research, beyond the more general research governance requirements, could encourage civil society engagement in the process of deciding the appropriateness of any research

* Corresponding author.
E-mail address: rob.bellamy@insis.ox.ac.uk (R. Bellamy).

http://dx.doi.org/10.1016/j.gloenvcha.2017.06.004
Received 16 September 2016; Received in revised form 8 June 2017; Accepted 16 June 2017
Available online 10 July 2017

efforts undertaken" (National Research Council 2015: 153; see also Rayner et al., 2013; Burns and Flegal, 2015). These calls join broader arguments for "upstream" citizen engagement in the formulation and assessment of scientific research agendas (Wilsdon and Willis 2004; Stilgoe et al., 2014), specifically in areas characterized by incertitude and ambiguity (Stirling, 2007), and where social commitments are still indeterminate or contingent (Wynne, 1992). The current emphasis on "responsible" forms of scientific research and innovation equally emphasize the need for governance processes that are anticipatory of impacts, reflexive of assumptions, inclusive with respect of the multiple possible framings of the matter at hand, and responsive to changing societal values and concerns (Stilgoe et al., 2013).

Social scientific research has begun to explore public perceptions of geoengineering, and has identified growing interest in the effective governance of scientific research and technical experimentation in this area. Deliberative workshops undertaken for the SPICE project testbed, for instance, suggested public support for greater transparency in research funding decisions, open publication of results, and new international governance and regulatory structures (Pidgeon et al., 2013). Focus groups on solar geoengineering have stressed the need for public confidence on at least five fronts: in climate science as a reliable guide to policy; in the ability of research to predict side effects; in the ability of research to demonstrate efficacy; in effective research governance; and in the capacity of democratic institutions to accommodate solar geoengineering technologies (Macnaghten and Szerszynski, 2013; Merk et al., 2015). Government-sponsored public engagement exercises on geoengineering proposals have elicited concerns about the controllability, reversibility, and cost-efficiency of different geoengineering options (NERC, 2010). Public appraisals of geoengineering proposals against other options for tackling climate change have led to three criteria for good governance: greater reflexivity in the articulation of geoengineered futures, the prioritization of broadly "robust" options and decisions over narrowly "optimal" ones, and the need to satisfactorily engage concerned publics before declaring geoengineering a legitimate object of scientific governance (Bellamy et al., 2016; Bellamy, 2016).

Despite these advances in the formulation of general principles for the effective governance of geoengineering, however, there is still little evidence on public perceptions of what might constitute a legitimate geoengineering experiment and how it should be governed (Parkhill and Pidgeon, 2011; Pidgeon et al., 2013). In this article we report the findings of a series of experimental deliberative workshops designed to elicit and explicate diverse understandings of geoengineering experimentation, and of the adequacy of different models of research governance. In contrast to previous methods of public deliberation, which have largely privileged egalitarian forms of discourse and consensual decision-making, we develop here a novel approach that places majoritarian, individualistic, and consensual models of public deliberation on an equal footing. Our study suggests that the controllability of experimental interventions is central to public perceptions of their acceptability, but that controllability is itself a multidimensional construct, encompassing concerns about physical containment, uncertainty about experimental outcomes, reversibility of impacts and conformity with ideals of 'pure' science. The ability of citizens to mix these four criteria in different combinations points to the limits of governance regimes that rely on a single parameter to define controllability, such as those premised on a purely linear determination of scale (large/small), or those that assume the overriding importance of physical location (indoors/outdoors). In light of these findings, we explore the multifaceted, non-linear nature of the "control dilemma" that characterizes the governance of emerging science and technology (Collingridge, 1982). We conclude by elaborating on the potential and limitations of our own experimental approach to public deliberation, and suggest some avenues for further refining our method.

2. Theory and method

To better explore public understandings of geoengineering research and views on the appropriate mechanisms for its governance, we devised three ideal-typical workshop formats: 'majoritarian,' 'consensual,' and 'individualistic'. As the names suggest, each workshop followed a different set of rules for argumentation and decision-making. We complemented these rules with a different style of facilitation and room layout for each of the groups, in an effort to encourage group dynamics aligned with the respective constraints placed on the process of deliberation. The three workshops were held on the same day in Norwich, Norfolk (UK), and were facilitated by the three authors.

In the majoritarian workshop, participants were compelled to reach a decision by majority vote, allowing, in the event of dissent, a single minority report. We provided the group with a theatre-style room layout, and enforced each participant's right to have the floor when speaking. The facilitator did not step in to facilitate the resolution of differences of opinion, nor did he assist in the formulation of an agreed group position. In the consensual workshop, participants were compelled to reach a unitary group position. Failing that, they were asked to represent in their conclusion every viewpoint expressed within the group. The facilitator ensured that every participant had a chance, and indeed an obligation, to speak, and guided the exchanges towards the articulation of a shared group view. The workshop took place in a room with a circular open space layout. Finally, in the individualistic workshop, which took place in a room with a boardroom-style layout, the facilitator encouraged the maximum articulation of individual viewpoints and the confrontation of differing opinions. He allowed individuals to try to persuade the rest of the group towards a consensus or majoritarian decision, but did not facilitate the emergence of a unitary position.

In designing each of these workshop formats, we took inspiration from the cultural theory of risk developed by Mary Douglas and Aaron Wildavsky (1982). The theory posits three ideal-typical worldviews, or 'cultures', on the basis of a preference for a particular kind of social organisation: hierarchical, egalitarian and individualistic. It argues that these biases will structure risk perception, a hypothesis that has been explored, through survey research, in relation to nuclear power (Peters and Slovic, 1996), genetically modified organisms (Finucane, 2002), nanotechnology (Kahan et al., 2009), and geoengineering (Bellamy and Hulme, 2011; Kahan et al., 2015).

In our exercise we attempted to translate the categories of cultural theory into deliberative formats. We modelled the majoritarian workshop after the hierarchical cultural type, the consensual workshop after the egalitarian type, and the individualistic workshop after the individualistic type. In developing specific modes of facilitation and decision-making for each of the workshops, we drew on work in social psychology that explores the configuration of "political atmospheres" or "social climates" in laboratory-like settings (e.g. Lewin et al., 1939). This body of work contends that different forms of political organisation can materialize in small groups under experimental conditions with the help of adequate facilitation techniques and socio-technical arrangements (cf. Lezaun and Calvillo, 2014).

We recruited participants to each of these workshops based on their affinity with hierarchism, egalitarianism or individualism, as measured by a psychometric survey modified from Dake (1991). This survey consisted of statements designed to measure degrees of affinity with each of the three cultures alongside a four-point Likert scale ranging from 'strongly agree' to 'strongly disagree' (see Bellamy and Hulme, 2011). Through this survey we also gathered information on sex, age, and National Statistics Socio–Economic Classifications (NS–SEC), the standard governmental measure of socioeconomic status in the UK, in order to produce a study population that was broadly representative for the county of Norfolk, although this was of secondary importance to recruitment on the basis of cultural predisposition.

The recruitment survey was administered online through Norfolk