



Original research article

Questioning the technological fix to climate change – Lay sense-making of geoengineering in Sweden

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ABSTRACT

This paper explores how Swedish laypeople make sense of emerging ideas of the large-scale deliberate technical manipulation of the global climate, known as geoengineering (GE). The paper is based on semi-structured focus group interviews with open-ended questions, allowing participants to express their spontaneous thoughts about GE. Although the focus group participants expressed great concern about climate change, GE was largely met with a sceptical, negative response. Participants perceived GE to: have negative environmental side-effects, address the symptoms rather than causes of climate change, create moral hazard and give rise to various governance challenges. Participants did not just reject the idea of GE outright; rather, social representations started to form in the focus groups through testing and negotiating arguments both pro and contra GE research and deployment.

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1. Introduction

Geoengineering (GE) refers to large-scale intentional technical manipulations of the Earth's climate system either by reflecting sunlight or removing carbon dioxide from the air. Examples of proposed technologies include stratospheric sulphur particle injection, marine cloud brightening, space mirrors, ocean iron fertilization, biochar and the direct engineered capture of carbon dioxide from the air [1].

Until 2006, GE was more or less considered unthinkable both in the climate change policy arena and in science.¹ In 2006 the Nobel laureate Paul Crutzen initiated a special issue of *Climatic Change* calling for active research into GE. He claimed that 'the very best would be if emissions of the greenhouse gases could be reduced so much that the stratospheric sulfur release experiment would not need to take place. Currently, this looks like a pious wish' ([2, p. 217]). This is still a widespread perspective in both public and scientific debates, but it is generally acknowledged that the likely

far-reaching environmental consequences of GE are poorly understood, raising ethical and governance concerns as well as questions about these options' technical feasibility (e.g. [3,4]).

The Intergovernmental Panel on Climate Change (IPCC) first included GE in its assessment reports in 2013. The inclusion of GE, deemed 'largely speculative and unproven' only a few years ago ([5, p. 15]), can be interpreted as signifying the normalization of these options. This opens up the possibility that GE may constitute an additional and potentially complementary category of options to address global warming, besides mitigation and adaptation strategies. However, the public's awareness of this potentially radical shift in climate change politics is very low (e.g. [6–8]), motivating emerging social science research into public deliberation, public perceptions and engagement with GE. So far, this research has had a strong UK–US focus (cf. [7]), prompting calls to explore GE assumptions and discourses in wider cultural contexts [9].

In response to the calls to broaden the geographical and cultural scope of social science GE research, this paper aims to explore lay sense-making of GE in Sweden. More specifically, and unlike other social science studies of public responses to GE, this paper starts from a social representations approach, which provides tools for analysing communicative processes involved in the formation of lay understandings [10]. Sweden exemplifies a country with limited scientific, policy and public debate on GE, making it an appropriate setting for exploring early public reactions to the idea of engineering the climate. At this early stage of research into

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¹ However, this does not mean that GE ideas have not surfaced earlier. For instance, Fleming [48] argues that weather modification has been discussed for more than a century.

Swedish lay understandings, we did not evaluate specific GE technologies or their various potentials and characteristics, but instead wanted study participants to explore the overarching idea of intentional grand-scale technical manipulation of the global climate. This is also how GE has so far usually been described in the international public media [4].

2. Public understanding of geoen지니어ing: an emerging research field

Previous research into the public understanding of GE can be broadly divided into two categories. The first is primarily quantitative and maps public opinions or perceptions. A few surveys have estimated lay knowledge or perceptions of GE ([7,8,11–13]; see also [14]), finding that only a few per cent of respondents had heard of GE and that even fewer knew about its basic principles. A survey of public perceptions of GE in the US, the UK and Canada found that only 8% of respondents were somewhat familiar with GE [6]. This study concluded that public opinion is in its formative stage and is sensitive to changes in framing and to future information on risks and benefits. In a major two-nation study of the USA and the UK, Kahan et al. [12] investigated how individuals relied on cultural meanings in forming risk perceptions. When exposed to GE information, respondents became somewhat more concerned about climate change risks.

The second category of studies applies qualitative approaches and primarily a public engagement perspective. Pidgeon et al. [13] have performed both a qualitative interview study and a survey on GE in the UK. In the interview study, researchers spent 5 min interviewing each informant about GE. Their interviews and questions were similar in structure to those used here, though we spent considerably longer discussing GE and closely related issues. In another study, Pidgeon et al. [15] applied a deliberative method to embed public dialogue in the innovation process. For two days their informants discussed GE, specifically, solar radiation management (SRM), in three workshops. The participants' main concerns were safety and unintended impacts, methodology and justification, knowledge limitations, governance and communication, overlapping the concerns identified in the present study.

Macnaghten and Szerszynski [16], taking a critical stance to the role of social science in public engagement, applied a deliberative focus group method in the UK, using an approach similar to Pidgeon et al.'s [13] by gradually introducing GE (SRM), not only to reproduce dominant framings but also to understand informant responses and what shaped them. Most importantly – and touching on the critical dimension – the researchers tried to interpret the governance implications of responses. Unlike previous studies, Macnaghten and Szerszynski's ([16, p. 472]) participants were claimed 'to arrive at more consistently sceptical positions about the prospect of geoen지니어ing'. Also, participants who initially conditionally accepted SRM became more sceptical when, what the authors call possibly more realistic, framings were introduced during the interviews. This change was tentatively explained by the observation that the participants then deemed deployment as unfeasible. One conclusion they draw is that the more the participants know about SRM the more sceptical they become.

There is ongoing discussion whether study participants need to be well informed about the technologies in focus. Daamen et al. [17] have questioned whether quick responses based on limited knowledge of technologies would provide valuable insight into public understandings. Their experimental study found that lay opinions, in this case regarding carbon capture and storage, could easily be changed by letting respondents perform irrelevant and annoying tasks for a few minutes. By contrast, Carr et al. [18] and Pidgeon

et al. [15] claim that it is not a prerequisite that participants have extensive knowledge of the technology in question, as even lay knowledge and limited input of basic knowledge from an expert can lead to well-reasoned argumentations and positions. Pidgeon et al. [13] maintain that laypeople tend to draw on a range of cultural narratives and personal experiences that can be related to the scientific topic being discussed in order to construct an understanding. In the present study, we pay particular attention to that phenomenon.

Aware of Daamen et al.'s [17] results, we paid special attention to group dynamics, for example, how respondents reacted to new information and other respondents' counterclaims. Also, the present study takes low awareness of GE as a starting point in studying emerging social representations among laypeople concerning something they have likely never heard of. We argue that exploring social representations of GE can help reveal lay assumptions and concerns about GE. The limited moderator intervention in our focus groups also enables analysis of how meaning is formed among the study's participants.

The novel contributions of this paper lie primarily in broadening the geographical and cultural scope of social science GE research beyond the current UK–US focus. In this respect, Sweden provides an interesting case of public GE ignorance. Also, the paper employs a more open-ended approach to focus group interviews, compared to most previous studies of public understandings of GE. This allows exploration of focus group participants' spontaneous sense-makings as well as of their responses to specific framings (in particular the climate emergency argument) introduced by the focus group moderators in the later parts of the interviews (see below). The paper is also novel in using a social representations approach, which to our knowledge has not been done previously in studies related to climate engineering.

3. Methods and materials

This paper is inspired by a dialogical interpretation of social representations theory (e.g. [10,19]). This theory concerns lay sense-making through the formation of shared representations of the surrounding world [10] – in other words, 'how people make sense of unfamiliar information' ([20, p. 2]). A social representation can be defined as 'a system of values, ideas and practices' regarding a given social object ([21, p. xiii]) or as 'mundane understandings which are commonsensical in character' ([22, p. 283]). When interpreted dialogically, i.e. focusing on how representations are formed and negotiated in social interaction between individuals [23], social representations theory is especially helpful in analysing how abstract science-based knowledge becomes commonsense knowledge with time. Two communicative processes are particularly important in the formation of social representations: 'anchoring' and 'objectification' [10]. Anchoring concerns how new phenomena are compared to and classified into well-known categories [24], while objectification concerns making abstract concepts more concrete, e.g. through the use of metaphors or prototypical examples [23].

The social representations approach has informed our choice of focus group methodology, as focus groups are recommended when the object of study is new to the participants and when social representations of it have still not become conventionalized [19]. We hypothesized that GE would be largely unknown to the study's participants, as there had been virtually no media coverage of this topic in Sweden at the time of the interviews. Under such circumstances, focus groups may provide a setting in which interacting participants try out understandings and arguments, providing opportunities to observe the joint formation and negotiation of social

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