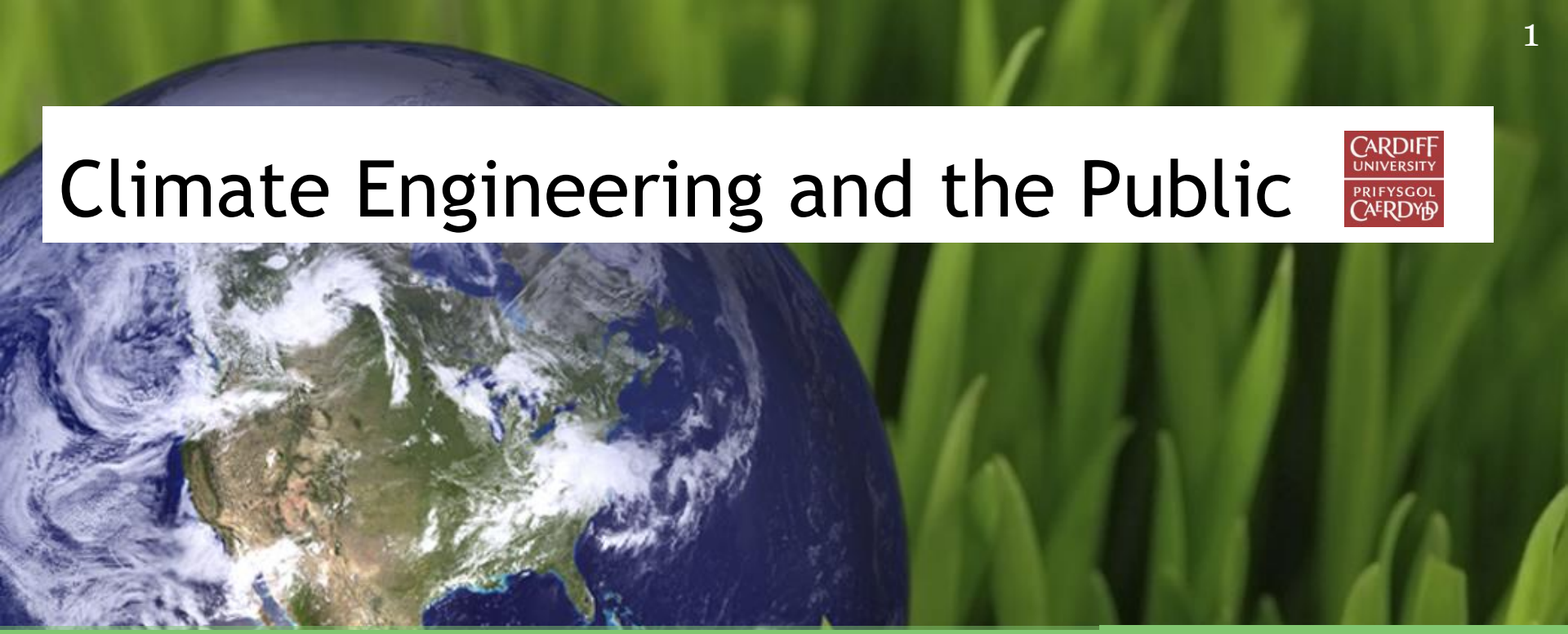
Climate Engineering and the Public



Nick Pidgeon

Understanding Risk Research Group and Integrated Assessment of Geoengineering Proposals Project (IAGP), Cardiff University

and NSF Centre for Nanotechnology in Society at UC Santa Barbara (Working Group 3)

IAGP Integrated Assessment of Geoengineering Proposals

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Working Group 3 - Risk perception & public deliberation team

UCSB, Cardiff (UK), UBC (Vancouver, CA)

1) Multiple party risk perception
2) Public participation/deliberation
3) Phase II Focus on 'emerging technologies', not just nanotech

NSF Cooperative agreement 0531185 (2010-2015)

Theoretical framework-SARF

- **Social amplification and attenuation of risk**
- **Risk amplification and technological stigmatization**
- **Framing of nano by media and advocacy groups**

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Integrated Assessment of Geoengineering Proposals (IAGP) Project

- **£2m Project, October 2010- September 2014 (Leeds, East Anglia, Cardiff, plus 4 others)**
- **Funding – EPSRC/NERC/STFC**
  - **Development of a Framework of Assessment**
  - **Technology Neutral / Critical**
- **To include Public Participation at both 'Opening Up' and 'Final Assessment' Phases** (cf. NRC Analytic-Deliberative Risk Assessment)

Climate Engineering - Some Ethical Considerations

(Corner and Pidgeon, *Environment*, 2010)

Should we intentionally manipulate the climate?

Unintended consequences and scale of interventions?

Consent - who should decide?

Global security, legality and trans-boundary issues?

Distraction from mitigation (moral hazard)?

Social construction of new 'risks'?

Emerging or 'Upstream' Risk Perceptions?

Lack of obvious history (hence this resides with other issues)

'Mental models' of risk processes are absent or ill-formed (analogies serve as proxy)

Everyday experience also absent

Inherent long-term uncertainties and potential regulatory gaps / lag

'Hype and hope' from technology promoters, dystopian narratives from (some) detractors

Pidgeon, Harthorn, Satterfield, *Risk Analysis*, 2011
Pidgeon et al, *Phil Trans Royal Society A*, 2012
Corner et al, *WIRES Climate Change*, 2012

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Public Views - USA

- Yale Climate Change Communication National Survey (n=2,030 US) June/July 2010 (Leiserowitz et al 2010)
- Calgary University qualitative and quantitative National Survey (n=3,000+, US, Canada, UK) Conducted Winter 2010 (Mercer, Keith, Sharp, *Env Res Letters*, 2011)
- USGAO National Survey (n=1,006) July-August 2010 (USGAO, 2011)
- Yale Experimental Study (n=3,000, US-UK) (Kahan et al, 2012)

Public Views - UK

- Royal Society Geoengineering Inquiry (4 focus groups, brief national survey n= 1,000) Conducted Summer 2009 (Royal Society, 2009)
- Cardiff University Interviews (n=42 households) Conducted Summer 2009 (*Phil Trans Royal Society A*, 2012)
- Cardiff University National Survey (n=1,822) Conducted Jan-March 2010 (*Phil Trans Royal Society A*, 2012)
- NERC/Sciencewise *Experiment Earth Public Dialogue*, Conducted March-April 2010 (Ipsos/Mori, 2010).
- Cardiff University 'SPICE' Workshops Jan-Feb 2011 (*Nature Climate Change*, 2013)
- Durham University Geoengineering Groups, Autumn 2011 (*Global Environmental Change*, 2013)
- Cardiff University Geoengineering Workshops, Spring 2012 (*Global Environmental Change*, 2013)

Public views - Emerging Findings 1

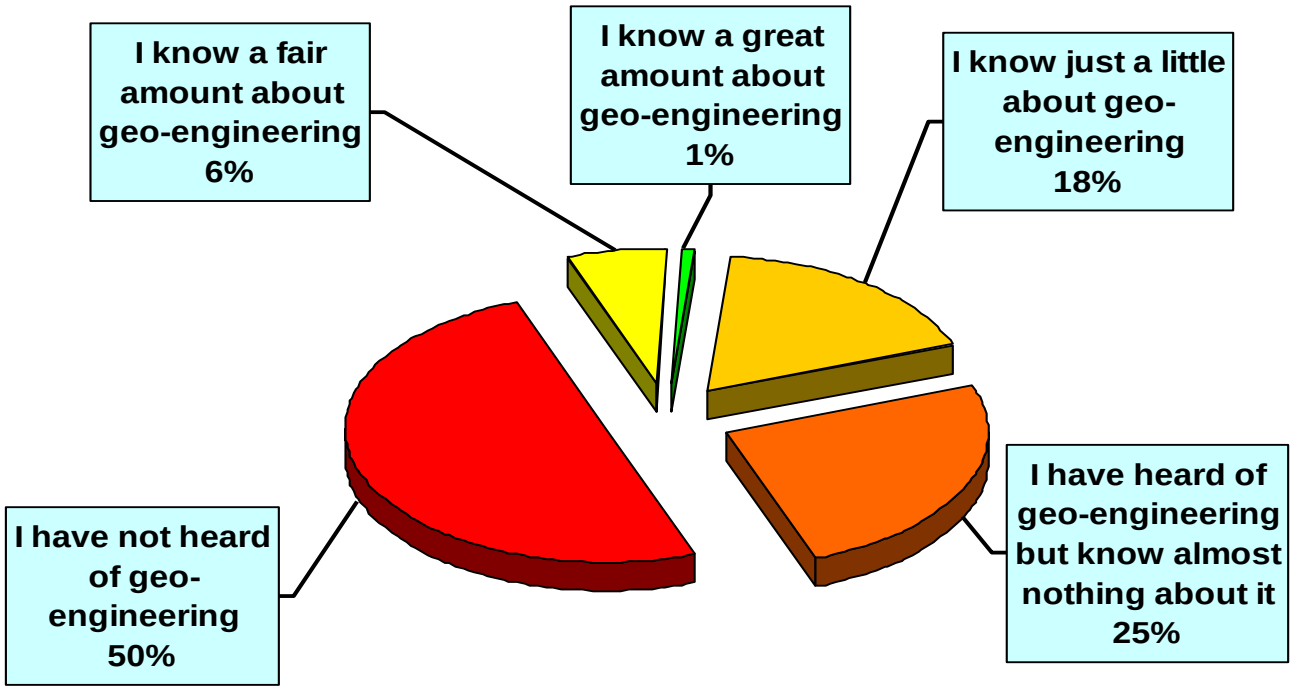
- Awareness and public knowledge are very low
- As a result public preferences/attitudes unlikely to be stable, but constructed and labile (e.g. Fischhoff and Fischhoff). Hence -
  - Terminology matters – because mental models based on available associations (e.g. 'geoengineering' often confused with 'geotechnical')
  - Survey responses depend heavily upon the question being asked
  - Need for innovative methods of study (informed choice, deliberative) but also need to attend to framing effects from information provision
- Note also multiple PUBLICS exist

Public views - Emerging Findings 2

WHEN GIVEN MORE INFORMATION

- People do not necessarily reject the idea ('science' still trusted)
- Type of geoengineering matters (e.g. forestation vs aerosols)
- Some limited evidence CDR is favoured over SRM
- Moral and ethical questions emerge (e.g. 'messing with nature', governance and regulation, long-term unknowns, effect on mitigation efforts)
- Cautious acceptance of limited research, but this does not signal full acceptance of deployment – acceptance is contingent
- Little clear evidence for 'moral hazard', so far

2010 GB National Survey –Knowledge (Jan-March 2010, n=1822) (source Pidgeon et al, 2012)



"The use of large-scale engineering projects designed specifically to combat climate change is termed 'geo-engineering'.

How much, if at all, would you say that you know about this subject?"

Definitions of 'Geoengineering' (US, Canada, UK, 2010)

Table 1. Distribution of incorrect definitions of geoengineering.

Category	% Distribution
Energy/Geothermal	5.7%
Genetic Engineering/Manipulation	6.2%
Other	8.3%
Engineering (unspecified)	8.8%
Geography	11.2%
Environmental engineering	17.1%
Geotechnical engineering	42.6%

While only 8% could correctly define 'geoengineering', a higher proportion (45%) could define climate engineering (primarily as 'weather modification')

(source Mercer et al, *Env Res Letters*, 2011)

Experiment Earth - Application Matters (Ipsos/Mori, 2010)

Carbon Dioxide Removal (CDR)	Solar Radiation Management (SRM)
Afforestation and Biochar. Consistently highlighted as preferred methods. Seen as 'natural' approaches and preferred for this reason.	**SRM** gained less support overall, as it was perceived not to tackle the root cause of climate change (greenhouse gasses).
Iron Fertilisation and Ocean Liming. Level of support for ocean-based methods was consistently low, although at the final event people were more prepared to consider these.	**Cloud Whitening** and **Sulphate Particles** were the most positively received (particularly the former) of the generally disliked SRM technologies, but were not endorsed by a majority.
Air Capture. Support for this increased throughout the deliberative events. Could be carried out at a local level without international regulation, and the results seen more quickly than afforestation.	**Mirrors in Space** were seen as expensive and risky, while **White Roofs** were viewed as likely to be ineffective and infeasible.

Figure 5.1 U.S. public support for actions on climate and energy, August 2010. Source: GAO.

Note: Estimates have 95 percent confidence intervals of within plus or minus 4 percentage points.

A Framework for Responsible Innovation

- Public Participation in Technology Assessment?

The 'Oxford Principles' for Governance of Geoengineering Research

Regulation as a Matter of Public Interest

Public Participation in Decisions

Open Access to Results

Independent Assessment of Impacts

Governance Before Deployment

(Rayner et al, 2013)

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The Bristol / Cambridge Stratospheric Particle Injection for Climate Engineering (SPICE) Project

- **To investigate the effectiveness of reflecting heat & light back into space using stratospheric particles**

- **A field component trial of a proposed aerosol delivery mechanism - but this element 'Stage-gated' by the funders**

- **Stage-gate Panel set for June 2011 (as a process of 'Responsible Innovation')**

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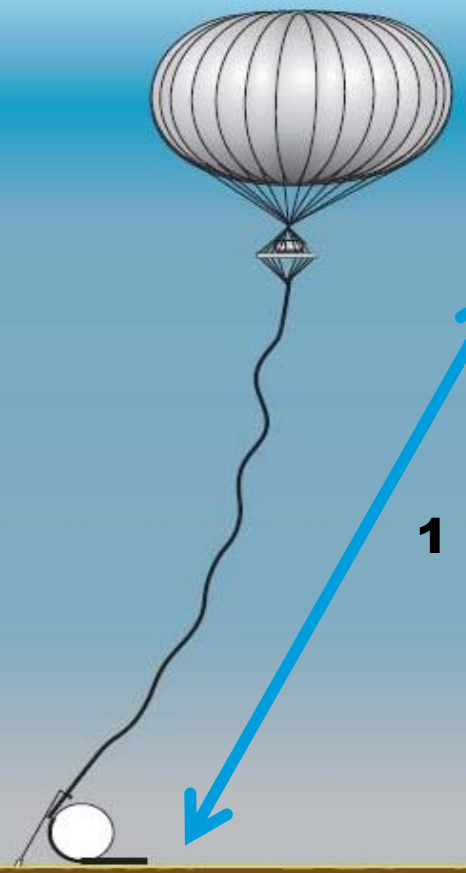
The SPICE 1km Test Bed - Research Objectives

1. How will the balloon react?

2. How will they get the balloon up and down?

3. How will the fluid behave once sprayed?



1 km Pipe

The Guardian | Thursday 1 September 2011

Want to mimic a volcano to combat global warming? Launch a Wembley-size balloon

Monster blimp would fire water into atmosphere

Scientists hope droplets can reflect the sun's heat

John Vidal
Environment editor

It sounds barmy, audacious or sci-fi: a tethered balloon the size of Wembley stadium suspended 20km above Earth, linked to the ground by a giant garden hose pumping hundreds of tonnes of minute chemical particles a day into the thin stratospheric air to reflect sunlight and cool the planet.

But a team of British academics will later this month formally announce the first step towards creating an artificial volcano by going ahead with the world's first major "geo-engineering" field test in the next few months. The ultimate aim is to mimic the cooling effect volcanoes have when they inject particles into the stratosphere that bounce some of the sun's energy back into space, so preventing it from warming the Earth and diminishing the effects of man-made climate change.

Before the full-sized system can be deployed, the research team will test a scaled-down version of the balloon-and-hose design. Backed by a £1.6m government grant and the Royal Society, the team will send a balloon to a height of 1km over an undisclosed location. It will pump nothing more than water into the air, but it will allow climate scientists and engineers to gauge the feasibility of the plan. Ultimately, they aim to test the impact of sulphates and other aerosol particles sprayed directly into the stratosphere.

If the technical problems posed by controlling a massive balloon at more than twice the cruising height of a commercial airliner are resolved, then the team from

Scientists hope to replicate the cooling effect a volcano has when it releases

So imagine how big a helium balloon you need to hold several double-decker buses – a big balloon. We're looking at a balloon which is possibly 100 to 200 metres in diameter. It's about the same size as Wem-

The SPICE Project Stagegate

(Pidgeon et al, *Nature Climate Change*, 2013)

Box 1 | The responsible innovation Stagegate evaluation criteria[26].

Criterion 1: The test-bed deployment is safe, the principal risks have been identified and managed, and are deemed acceptable.

Criterion 2: The test-bed deployment is compliant with relevant regulations.

Criterion 3: The framing of the project (nature, purpose) for external communication is clear and advice regarding this has been obtained.

Criterion 4: Future potential application(s) and associated impact(s) have been described and mechanisms put in place to review these as significant information emerges.

Criterion 5: Mechanisms have been identified to understand wider public and stakeholder views regarding these envisaged applications and impacts.

The Cardiff 'SPICE' 2011 Deliberation

- **Explore possible public concerns, questions, and conditions regarding SPICE and geoengineering more generically**
- **To map the range of perspectives and framings on the SPICE Test-bed field trial**
- **Structured Micro-dialogue - blend of balanced, information provision and citizen debate (e.g. World Café)**
- **Provide one piece of evidence for consideration by the Research Council's responsible innovation Stage-gate Panel**
- **NB – INDEPENDENT OF SPICE**

DAY 1 (Pidgeon, at al *Nature Climate Change*, 2013)

Climate Change (Thought listing task, open discussion & World Café 1)

Mitigation	Adaptation	Remediation - Geoengineering (CR & RA)

Geoengineering (Presentation on techniques & World Café 2)

Reflective Approaches – Ethics and Governance prompts	Carbon Removal – Ethics and Governance

DAY 2

Homework

SPICE (Presentation - KP, Q&A with rep & Small group discussion)

Each small group discusses SPICE in relation to other broad responses to CC, other geoengineering techniques & ethics/governance	Small group feedback to the group acting as stimulus for large group discussion

SPICE Findings – Test-bed specific

(Pidgeon, at al *Nature Climate Change*, 2013)

- Transparent & open ongoing multi-modal engagement with local publics
- The test-bed can only proceed if it is safe for both local inhabitants and the local environment, and information relating to the safety and impacts of the test-bed should also be made publically available

Public's Questions: Governance and Communication (Pidgeon, at al *Nature Climate Change*, 2013)

- What international links are there?
- Will other countries mind any outfall?
- What will be done with the information from the test-bed?
- What will be done with the results?
- How will the results be shared with other countries?
- Do we know what research is happening elsewhere?
- How is the test-bed being publicised?
- How will they inform people?
- What will you tell the local people about it?
- How will local government, councils etc be involved?
- Who's accountable if things do go wrong?
- Will scientists from other countries be involved with the full-scale project?
- Who would be in control of the full-scale project?

Public's Questions: Knowledge Limitations (

- To what extent can you upscale the findings from 1km to 20km?
- How can we relate small scale to large?
- How can the results from the test-bed be applicable to the longer pipe?
- How can the data from the test-bed be used?
- How will this address the wider risks of stratospheric aerosols?
- How much can we learn about the cooling effects from this type of trial?
- Can the other effects (e.g. wind, temperature and other effects) all be scaled up?
- How will impacts be tested of the full size project?
- How will the negatives of the 20km pipe be dealt with? Are the other potential negative impacts/cons of using stratospheric aerosols also being investigated in the project?
- How will fresh and salt water behave differently?
- What would be, for Full-scale deployment, the impacts of temperature (e.g. frozen pipe?) and will the test-bed help?

"You know the results from doing the test-bed, how will they take that, how will that be the same as if they do it on a full scale?" (Margie, Nottingham).

SPICE Findings – Broad Level

Pidgeon, at al *Nature Climate Change* (2013)

- Conditional acceptance of test-bed research as presented BUT still significant concerns regarding stratospheric aerosols beyond the test-bed, including justification, efficacy, equity, ethics and governance (as 'objects' inhabiting different discursive frames).

- A key concern was that international governance and regulatory structures be under development now to help govern and co-ordinate research such as the test-bed and SPICE.

Research per se is interesting and I'm quite happy for scientists all over the world to be pursuing research into an awful lot, wonderful and quirky ideas, because you never know what good will come out of them and an awful lot of good has come from an awful lot of research over the years. So research in itself is absolutely fine, but scaling up would then be where I'd start to have reservations.

(Riley, Norwich).

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