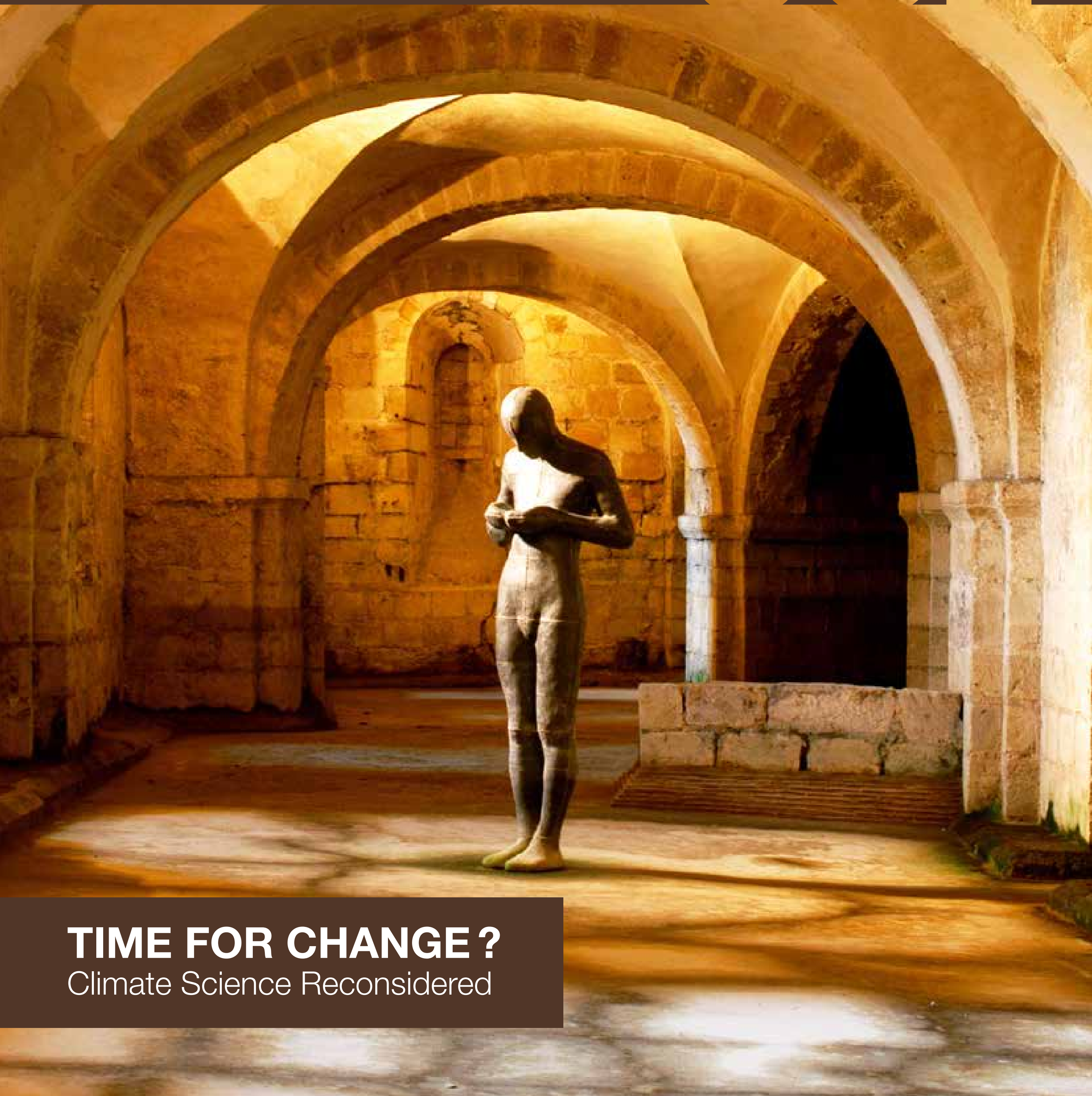
UCL POLICY COMMISSION ON COMMUNICATING CLIMATE SCIENCE



TIME FOR CHANGE?
Climate Science Reconsidered

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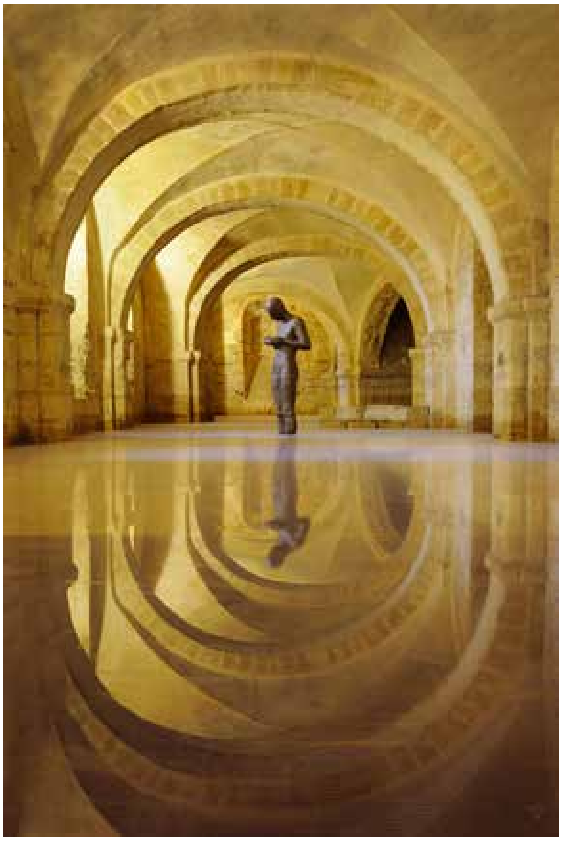
The Report of the UCL Policy Commission
on Communicating Climate Science



Cover and above:
Sir Antony Gormley's *Sound II*, installed
in the crypt of Winchester Cathedral.
Photography by Joe Low

“Urgent and unprecedented environmental and social changes challenge scientists to define a new social contract. This contract represents a commitment on the part of all scientists to devote their energies and talents to the most pressing problems of the day in proportion to their importance, in exchange for public funding.

The new and unmet needs of society include more comprehensive information, understanding, and technologies for society to move towards a more sustainable biosphere – one which is ecologically sound, economically feasible, and socially just.

New research, faster and more effective transmission of new and existing knowledge to policy- and decision-makers, and better communication of this knowledge to the public will all be required to meet this challenge.”

Extract from Jane Lubchenco’s Inaugural Speech as incoming President of the American Association for the Advancement of Science, *‘Entering the Century of the Environment: A New Social Contract for Science’*, delivered in 1997

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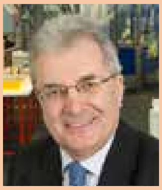
FOREWORD



I have found this Foreword quite difficult to write. Forty years practice of expressing my thoughts in a particular 'scientific' way is hard to change. But the core conclusions of the report – that we climate scientists need to reflect critically on what we do and take steps to better match it with societal needs – apply to us all. My experiences having moved from experimental space science, through running large international research programmes and a research institute, to running the Science Museum in London, have convinced me that our training and development has left us insufficiently prepared to contribute as effectively as we should both to public policy, and to communicating our results and conclusions to society more generally. We are especially ill-equipped to deal with controversy in the media and to respond to public attacks on our motivations and behaviours.

It was this background that led UCL to establish a Policy Commission to consider how to improve the communication of climate science. Originally the plan was to focus on what could be learned usefully from the 'mind sciences'. However, as the project developed the need became apparent to extend its remit to gain a wider and deeper understanding of the ways that climate science is conducted and how its results are delivered to society. The outcome has been a fascinating journey of discovery into areas not commonly explored by climate scientists – and some conclusions that may themselves raise some controversy.

For my own part, the exercise has brought home sharply the extent to which every one of us is vulnerable to being misled by 'common sense' explanations of complex evidence, events and circumstances. The fact that as a scientist I have not previously invested appropriate effort into evaluating the strengths and weaknesses of my primary research instrument – my mind – is salutary. As a physicist, the realization that evolution has honed my mind to seek ‘meaning in context’, rather than an ever more perfect representation of the world, is profound. The result is a heightened recognition of the need constantly and with determination to scrutinize my own emotions and thought processes – to step outside and ‘see myself see’ - in order to minimise the possibility of unwitting bias and faulty reasoning. The same need applies to everyone involved in the climate science discourse.

This Report thus explores issues which the Commission considered to have previously been given insufficient attention. The primary audience is the climate science community, their employers and those who educate and train climate scientists, especially those individuals amongst these groups who perceive and are concerned about a mismatch between existing practices and societal needs. The conclusions and recommendations offer ways in which the expertise and impact of the climate science community can be strengthened. Such reforms alone will not be sufficient to achieve a more constructive and effective formulation of policy and an improved public discourse, but they provide a crucial step towards achieving those objectives.

May 2014

Prof Chris Rapley CBE
Chair, UCL Policy Commission on Communicating Climate Science

CONCLUSIONS

- **Climate scientists are finding themselves ill-prepared to engage with the often emotionally, politically and ideologically charged public discourse on the evaluation and use of their science.** This is proving unhelpful to evidence-based policy formulation, and is damaging their public standing. As a result, there is a pressing need to re-examine and clarify the roles of climate scientists in policy, decision-making and public engagement. Their professional norms, values and practices need to be reconsidered and revised accordingly. In expanding their skills and expertise to better match societal needs, climate scientists can benefit from a mutually supportive working relationship with social and behavioural scientists, and with experts in public engagement and communication. Such reforms alone will not be sufficient to achieve a more constructive and effective formulation of policy and an improved public discourse, but they provide a crucial step toward those objectives.

- **A climate science 'meta-narrative' is required** that delivers the results of climate science in a manner that is accurate, engaging, coherent, relevant, and which – by making clear the limits of certainty and knowledge – is robust against new discoveries and unfolding events. Multiple narrative threads, that are consistent and harmonious with each other, are necessary both to reflect the complex nature of the climate science, and to connect with audiences with different states of knowledge, interests, values and needs.

- **Policy issues raised by climate science are complicated by many factors** such as decisions on energy, food and water supplies, quality of life, equity, affordability, security, sustainability and societal resilience. Whilst climate science can inform such policy deliberations, it cannot be their arbiter. Decision-making should not be through the 'linear' mode, characterized as 'truth speaks to power', but by a collective process ('co-production') in which all interested parties, including the public, play their part.

- **Efforts to understand the climate system better are important, but they should not be allowed to divert attention and effort from decision-making and policy formulation based on what is already known and can be addressed.** Reducing uncertainties in some areas may not always be possible but irreducible uncertainties can be addressed using a 'decision pathways' approach, which retains flexibility through the identification of multiple options and decision points.
- **At its root, the public discussion of climate science is as much about what sort of world we wish to live in, and hence about ethics and values, as it is about material risks to human wellbeing.** This needs to be clearly acknowledged and addressed by climate scientists, policymakers and others engaged in the discussion. Establishing a positive and active public discourse requires recognizing that people's feelings, beliefs, inner conflicts and world views strongly influence the way that they receive and assimilate information.
- **New organisational mechanisms are required** to support the public discourse on climate science and to achieve necessary professional reforms – notably a forum for active public discussion and a professional body for climate scientists.

RECOMMENDATIONS

Communication

There is a need for an operational means for the general public and climate scientists to engage in dialogue, and for the provision of a coherent 'meta-narrative' of climate science that conveys the big picture and provides the context for discussion of the results, their uncertainties and their implications. The authentic and personalised voice of climate scientists in the formation and delivery of this 'meta-narrative' will be crucial. It will require the climate science community to develop and discuss the narrative in a way that seeks to increase the transparency of the scientific process and to strengthen public participation within it. The effective communication of this 'meta-narrative' will rely on successful use of and engagement with the media and the internet.

Training

There is a need to enhance the training and development of climate scientists. Specifically the objective is to equip the community as a whole with the skills to fulfill the roles of 'pure scientist', 'science communicator', 'science arbiter', 'issue advocate' and 'honest broker of policy alternatives'. This will require effective action on the part of funders and universities to support and deliver the necessary training. The broader aim is to strengthen the functioning and transparency of the climate science process, and the degree of public participation within it.

Policy

Climate scientists should participate actively in the 'co-production' of policy formulation and the decision-making process. This entails contributing their expertise alongside other experts and stakeholders to inform the deliberations of those with the authority, responsibility and accountability to make decisions. Progress will require a willingness and openness on the part of Government and other policy stakeholders, as well as climate scientists, to commit to such an approach.

Leadership

A professional body for climate scientists should be established to provide a unifying purpose and to offer leadership. Its roles should be as follows:

- **Representation:** to represent the interests of scientists and of society.
- **Voice:** To provide the means for climate scientists to develop and communicate the climate science 'meta-narrative' and to work with experts in wider aspects of public engagement and communication to support this.
- **Standards:** To define professional norms, values and practices appropriate to societal needs and provide guidance and input to improve the training and development of climate scientists accordingly.
- **Outcome:** To support climate scientists in engaging in co-production of policy by defining the associated roles and expectations, and by providing a clear route for engagement between the climate science community and policymakers.

To these ends the body should facilitate a mutually supportive working relationship between climate scientists, social and behavioural scientists, and key stakeholders, with the aim of applying relevant insights to the practice of climate science.

Self-reflection

Active critical self-reflection and humility should become the evident and habitual cultural norm on the part of all participants in the climate discourse. We need to be vigilant in scrutinising how we evaluate evidence and judge others. We are all less rational and more rationalizing than we think.

CHAPTER SUMMARIES

1

Clarifying the Science–Policy Interface

Responsibility, authority and accountability for decision-making and policy formulation should lie transparently with the relevant decision-makers, policymakers and politicians. Climate science can inform, but should not arbitrate, policy; rather climate scientists and policymakers need to work together, and with other experts and the public, to develop and practice a 'co-production' approach to policymaking. There are five key roles which climate scientists should collectively fulfil: 'Pure Scientist', 'Science Communicator', 'Science Arbiter', 'Issue Advocate' and 'Honest Broker of Policy Alternatives'.

2

What is Inside Our Minds?

Disagreement within climate discourse is more to do with differences in values and world-views, and our propensity for social evaluations, than it is about scientific facts. Climate science contains enough complexity and ambiguity to support a variety of positions. Simply providing more facts will not resolve the disagreements.

Findings from the social and behavioural sciences explain how people, given identical evidence, can come to opposing conclusions. They also provide an explanation for people's natural inclination to denigrate those who hold opposing convictions. Taken together, these two insights help to explain the contested nature of climate science. An understanding of these issues can help climate scientists to better carry out their role as Pure Scientists, as well as to interact with the public more effectively and productively.

3

Strengthening the Public Standing of Climate Science

Climate science is complex, and its results are unwelcome, inconvenient and contested. It cannot be easily rendered into simple truths. Furthermore, the climate science community is very broad and lacks a coherent unified voice. The internet offers opportunities for greater transparency and public participation in climate science, whilst the concept of 'brand DNA' provides a helpful means of identifying ways to strengthen the coherency and credibility of climate science's messages. One way for climate scientists to engage more effectively with society and with policymakers is to encourage and inform discourse on tractable, 'no or low' regret ways forward. These should address different benefits on different timescales, starting with the near term.

4

Capturing an Engaged Audience

Narrative offers a powerful means to engage an audience and convey complex concepts. Climate scientists can gain much by working with and learning from those expert in public discourse, including the arts, museum sector and media. When talking to the lay public about climate science, scientists should avoid undue reliance on the 'information deficit' approach and overcome their reluctance to employ the elements of successful narrative, including personalizing their story, drawing on emotions and expressing their opinions. Dialogue, rather than debate, offers the means to identify common purpose and foster constructive, evidence-based discourse.

Continued >

5

How Climate Change Features in the Public Consciousness

There is widespread public acceptance of the reality of climate change, but not of the urgency and scale of the challenges that the science indicates it represents. This discrepancy derives from psychological factors and from cues from influential elites and the media. There is a need to reframe the public discourse in a way that circumvents existing entrenched positions to engage climate scientists and other experts with policymakers and society more generally to evaluate the scientific evidence and determine the appropriate responses.

6

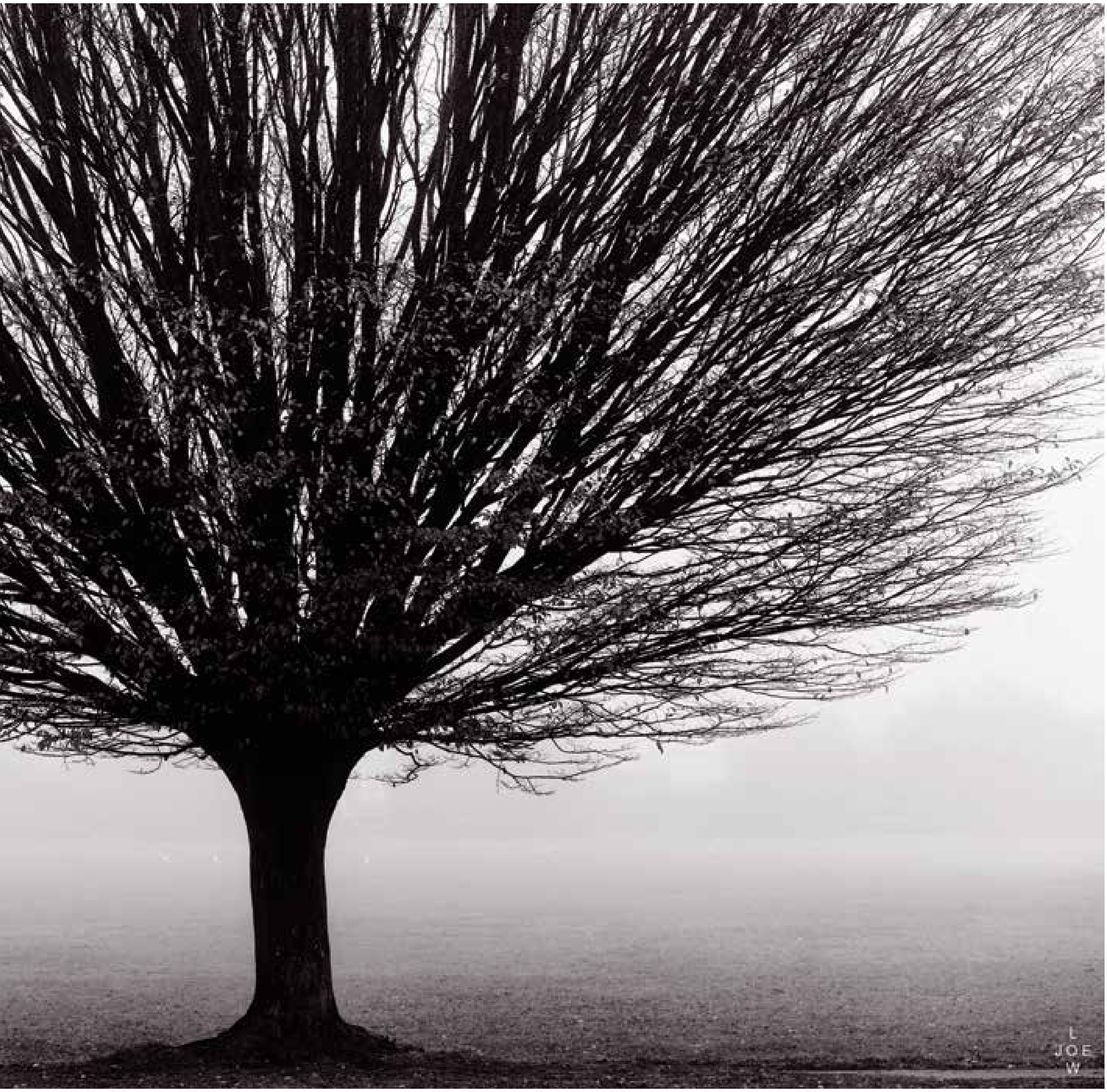
Rising to the Challenge

In an ideal world, the climate science community would have a clear understanding of its purpose and objectives, pursue proactive engagement with society and policy through a clear narrative of climate science, engage in dialogue rather than debate, and be aware of the need for active self-reflection. It would support a productive discourse on the challenges of climate change and would address a number of fundamental needs, including: a forum for authoritative public conversation; a means for representing climate science in societal engagement; professional credentials and standards for climate scientists; and high standards of education and training.

A means to achieve these ends would be the establishment of a professional body for climate science, to represent the interests of both climate scientists and of society, and to develop norms, values and practices better tuned to the circumstances in which climate science finds itself.

Photograph Joe Low

Report Contents



Photograph Joe Low

Introduction

KEY POINTS

- Climate science as currently practised finds itself mismatched to societal needs.
- Climate scientists need to reconsider their roles and expand their knowledge and skills accordingly.
- A change in the relationship between climate science and society is required.

In 1997 Jane Lubchenco, the newly appointed President of the American Association for the Advancement of Science, delivered an inaugural speech entitled *Entering the Century of the Environment: A New Social Contract for Science*[1]. In it she emphasized that humans have emerged as a new force of nature, dominating the planet, and potentially threatening its life support systems. As a result, it is incumbent on researchers "privileged to be able to indulge their passion for science – and simultaneously to provide something useful to society" to consider carefully their responsibilities and to seek to fulfil them to the best of their abilities. She invited the environmental science community to "participate vigorously in exploring the relationship between science and society and in considering a New Social Contract for Science as we enter the Century of the Environment". The speech and its publication generated much interest, and were widely hailed as visionary.

In the subsequent 17 years climate science has developed into a major enterprise. The number of researchers working in the field now runs to tens, if not hundreds, of thousands worldwide[i]. In 2013 alone around 13,000 papers were published under the classification 'global climate change' or similar[ii], and US research expenditure via the US Global Change Research Program, corresponding to about half of that worldwide, amounted to some $2.5 billion[2].

Yet, over that same period, notwithstanding some notable exceptions, the day-to-day practices of the majority of climate researchers has changed relatively little. Whilst a growing subset have involved themselves in the communication of results beyond their scientific peers, and some have participated in forms of societal decision-making and policy formulation, the primary focus and motivation for most remains the carrying out and publication of original research. Neither the 'vigorous debate' encouraged by Lubchenco, nor a resulting shift in emphasis, has taken place.

In the meantime, the public discourse has become fractious and polarized. The results of climate science are routinely dismissed, and climate scientists denigrated[3–5]. The climate science community is finding it difficult to marshal a coherent and effective response[6].

This is very unhelpful, given the enormity of what is at stake. If society fails to respond appropriately to climate risk the consequences could be irreversible. Answers to the questions 'Are humans disrupting the climate system?' and 'What will happen if they are?' address objective realities amenable to scientific enquiry. The determination of what could, and should, be done in response are issues that can be illuminated, but not decided, by climate

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i The American Geophysical Union (AGU) has a membership of over 61,000 in 144 nations. More than 70% of AGU members classify themselves in a field of research that contributes to climate science. However, only a subset would regard themselves as climate scientists. Many climate scientists are not AGU members.

ii The figure derives from a Web of Science search with 'global climate change' as the topic.

science. A thoughtful, well-informed and constructive public discussion is merited. Procrastination is potentially risky.

But progress is hindered by an increasingly entrenched battle between those who accept that transformative action is necessary and those who do not. Climate science is centre stage and is regularly employed in a selective manner by protagonists seeking to justify their stance and vanquish opposing views. As well as undermining the ability of society to address effectively the climate change issue, this is proving detrimental to the standing of science and to the reputation of scientists, and threatens to weaken the role of scientific evidence in wise, democratic decision-making.

What is going on? Why is it that the results of multiple lines of scientific enquiry regarded as robust by specialists are dismissed – even ridiculed – with determination and contempt? How can climate scientists communicate their messages more effectively? How can their contribution to the climate change discourse and policy formulation be improved to benefit the public good?

This report considers these and related questions. We explore the intersection of science and societal decision-making, and summarise recent thinking on the roles and obligations of researchers carrying out 'policy-relevant' science[iii]. We draw on the insights of the social and behavioural sciences to demonstrate the need for active critical reflection on the part of climate scientists, as well as all others involved in the public discourse on climate science. We discuss the forces at work in the formation of societal reactions to the results and implications of climate science, and especially the propensity for widely differing interpretations of evidence and antagonism to others. We identify a number of issues that threaten the public standing of climate scientists, and consider how these can be addressed.

Based on our analysis, we identify ways in which climate scientists could usefully enhance their knowledge and expertise, and strengthen

iii By which we mean science that is relevant to significant issues of public policy.

their approach, recognising that this is a necessary but insufficient condition to improve the effectiveness of the public discourse. We recommend the creation of a communications forum for climate science, and of a professional body for climate scientists. The purpose of the communications forum is to engage actively with the public in a discourse on the results and implications of climate science, thereby building interest, understanding and trust, and to develop and convey a 'meta-narrative' which is accurate, engaging, coherent and relevant, and which – by making clear the limits of certainty and knowledge – is robust against new discoveries and unfolding events. The purpose of the professional body is to provide a means to represent the interests of climate scientists and those of society, and to provide the necessary means and the leadership to develop and implement professional norms, values and practices that match the needs of the modern world.

Sir Antony Gormley's *Another Place* Installation Crosby Beach. Photograph Julia Pitts

CLARIFYING THE SCIENCE–POLICY INTERFACE

Chapter 1

KEY POINTS

- The 'linear' or 'technocratic' model of science informing climate policy is inappropriate. Climate scientists and policymakers need to work together, and with other experts and the public, to develop and practice a 'co-production' approach.
- Responsibility, authority and accountability for decision-making and policy formulation should lie transparently with the relevant decision-makers, policymakers and politicians.

  Climate science should inform policy decisions but should not be their arbiter.
- Climate scientists should collectively fulfil five roles: 'Pure Scientist', 'Science Communicator', 'Science Arbiter', 'Issue Advocate' and 'Honest Broker of Policy Alternatives'.
- Climate scientists and political scientists need to engage with and learn from each other.

1.1 The 'Linear Model'

Explicit within Jane Lubchenco's 1997 rallying call was the recognition that the established post-Second World War 'linear' relationship between science and policy – characterised as 'truth speaks to power, and power responds' – needed reconsideration. Mike Hulme, in his book *Why We Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity*[7] calls the linear approach the 'technocratic model', and notes that "it is founded upon a classic view of discoverable and objective 'facts', which are socially and politically neutral, and the belief that all relevant facts can be revealed by science". Once the nature of a problem has been characterized by science, responsibility moves to policymakers to address it in the best interests of society.

Roger Pielke Jnr, in his book *The Honest Broker: Making Sense of Science in Policy and Politics*[8], draws an analogy with decision-making over an approaching tornado ('tornado politics'). Even in the presence of irreducible uncertainty about the level of risk ('Is it really approaching?' 'Will it really hit us?' 'How damaging will it be?'), there is sufficient unity of purpose that action (taking cover in the basement) follows with little delay or disagreement. Under such circumstances of broad consensus on a common goal ('save ourselves'), with low cost ('run downstairs') and no practical obstacles ('there is room for all of us'), the linear model functions well.

However, in circumstances where interests, values and beliefs strongly differ, resulting in there being no agreement on a common goal, or when costs are high, or the practicalities problematical, the linear model fails. This is especially the case if the science (and hence level of risk) is uncertain, or when the science has no traction on the root causes of the different policy positions in play. Pielke offers an analogy of 'abortion politics', in which deeply held and opposed views rooted in ideology, religion, morals or ethics can be informed but not resolved by science[iv]. Dan Sarewitz[9, 10] points out that under such circumstances, if the linear model is applied, "more research and more facts often make the conflict worse by providing support to competing sides in the debate, and by

iv In his book *The Climate Fix*, Pielke refers to the 'naturalistic fallacy' – the false impression that you can obtain an 'ought' from an 'is' (p197).

distracting decision-makers and the public from the underlying, political [ideological, religious, moral, ethical] disagreement".

Since all participants have accepted the ground rule that science is the arbiter that can and will determine the policy decision, the scientific evidence becomes the primary focus of dispute. Under pressure to prevail, the rules of rational discourse – which pursue 'objective truth' using an established process of inquiry, logic and validation based on impartiality and balanced evaluation of all the evidence – are susceptible to being abandoned by some protagonists in favour of the rules of political street-fighting, in which opinion, rhetoric, appeals to emotion, character assassination, cherry-picking and the distortion or misrepresentation of evidence are regarded as 'fair game'. Under such circumstances, those who abide by the rules of science find themselves at a substantial disadvantage, especially if the distinction is not apparent to the audience. We will refer to this as 'debate asymmetry' and return to it later.

Human-induced climate change exhibits characteristics that make it arguably the poster child of 'abortion politics'. It has been described as a problem "almost perfectly designed to test the limits of any modern society's capacity for response"[11]. Despite this, the linear model remains ubiquitous. It forms the approach taken by the Intergovernmental Panel on Climate Change (IPCC), charged with advising policymakers "on the state of climate science, the implications and the policy options"[v]. Although policymakers vet and agree the scope of the reports and their content prior to publication, the core material – consisting of a comprehensive review and synthesis of thousands of scientific publications – is produced by the science community based on its own perception of what is important[12]. The 'evidence' so produced is then used to inform the related but separate international negotiations under the auspices of the United Nations Framework Convention on Climate Change.

v IPCC Working Group I evaluates the scientific evidence for human-induced climate change, its nature and its likely future trajectory of the climate system; Working Group II then identifies and evaluates the implications; and Working Group III follows up with policy options.

A myriad of other examples exists, ranging from the participation of the climate science community in the international conference Avoiding Dangerous Climate Change[13], commissioned by the UK Government and hosted at the UK Meteorological Office in 2005 with the objective of "identifying what level of greenhouse gases in the atmosphere is self-evidently too much", to the philosophy underlying the US Global Change Research Programme[14]. It is also deeply engrained in the origins of the new initiative Future Earth, being developed by the International Council of Science as a 21st century follow-on to its previous Global Change programmes. Despite repeated references in its descriptive material to "co-production with society"[15,16], climate scientists have defined the programme and its research agenda (a list of priorities is provided); policy (and outreach) are then assumed to follow, albeit with consultation. At the time of writing, the Science Committee has already been appointed, whilst an Engagement Committee is still to be established. This deep-rooted technocratic mindset is encouraged and reinforced by the exhortation to researchers in 2011 by the Belmont Forum[17], a coalition of the major environmental research funding agencies from around the world (and a major influence on Future Earth), to "develop and deliver knowledge in support of national and international government action to mitigate and adapt to global and regional environmental change".

We will consider below possible sources of reluctance or difficulty in abandoning the linear model. But we note that the insights of Sarewitz, Hulme, Pielke and others indicate that the linear model not only represents an inappropriate means of making progress to address the risk of climate change, but that by adopting science as the arbiter of policy it ensures the inevitability of the types of attack which climate science and climate scientists are currently experiencing.

1.2 The ‘Co-Production’ Model

The persistence of the linear model is all the more surprising in the light of a considerable body of work in science and technology studies that exposes its limitations, and the early recognition within the academic community that climate policy would necessarily have to defer to other priorities. In 1991, Bill Mitchell, a physicist and one-time Chairman of the UK Science and Engineering Research Council concluded in a paper entitled *Reflections on Global Climate Change*[18].

> “Given the objective of improving the standard of living of currently 50% of the world’s population, over whatever period, the concentration of greenhouse gases will certainly increase, and will certainly not decrease. It follows that research priorities have to reflect living with a probable increase in global warming. This means developing new agricultures, using unused land, and, even, encouraging means of population migration.”

At about the same time, social scientists Silvio Funtowicz and Jerome Ravetz published their concept of ‘post-normal science’[19, 20]. They argued that the call for science to “remedy the pathologies of the global industrial system” necessitated new styles of activity “replacing the reductionist, analytical world-view by a systematic, synthetic and humanistic approach, based on assumptions of unpredictability, incomplete control and a plurality of legitimate perspectives”. They went on to describe a methodology applicable when either or both of ‘systems uncertainties’ or ‘decision stakes’ are high, under which circumstances the traditional methodologies that they identify as core science, applied science and professional consultancy, are ineffective. They likened the practice to the workings of a democratic society, characterised by extensive participation and toleration of diversity.

Hulme describes this as the ‘co-production model’ (or ‘Mode 2 science’[21]) in which the goals of policy and the means of achieving them emerge from an inclusive and iterative process taking into account both scientific and non-scientific considerations. He describes an approach that through open consultation across society establishes the dimensions of risk that actually matter to people, followed by an assessment and explanation by experts of the risks of different degrees of climate change, and a stage in which policymakers and politicians are required to argue and negotiate in public about what level of risk is tolerable. Science is called upon to inform the discourse by answering to its best ability specific, positive questions. Through this process, in which the influences of power politics and subjective biases of all participants – including the scientists[22] – should be exposed, evidence-based and well-considered policy emerges with the understanding, if not support, of all involved. He notes that the co-production model is sympathetic to framing knowledge in terms of risk, adopting a Bayesian approach where appropriate, in which uncertainties are inherent and visible.

A real-life example is provided by the Swedish government's initiative to select the sites of permanent storage repositories for nuclear waste, in which a nationwide search and competition was established for communities that would be willing to host a site investigation and potentially the repository itself[23]. Within the UK public enquiries and citizen's juries, as well as the activities of congregational bodies such as local councils, residents associations, churches, unions of all types and movements such as the "Transition Towns Movement ", provide a basis upon which co-production could be built and expanded.

Importantly, the co-production framework integrates scientists and their work into the decision-making process in a manner which is collaborative and constructive, and where responsibility, authority and accountability for policy lie transparently where they should: with the policymakers and politicians.

1.3 Roles of a Climate Scientist

What are the functions that climate scientists can fulfill within the co-production model? How do these relate to their established norms and practices? Pielke explores the former question in his books *The Honest Broker*[8] and *The Climate Fix: What Scientists and Politicians Won't Tell You about Global Warming*[24]. He identifies four idealised roles for scientists, as set out below.

Pielke's four idealized roles

The **'Pure Scientist'** focuses solely on generating 'facts' and delivering them to the 'pool of human knowledge', with no consideration for their use or utility, and no direct connection with decision-makers, who are left to find out for themselves what they need to know.

The **'Science Arbiter'** seeks to stay removed from explicit considerations of policy and politics but answers factual questions posed by a decision-maker. A key characteristic is to avoid normative questions, which cannot be resolved by scientific enquiry, and focus on positive questions, which can (at least in principle).

The **'Issue Advocate'** engages with a decision-maker seeking to reduce the scope of choice available by promoting a particular course of action that they justify using their expert knowledge and understanding.

The **'Honest Broker of Policy Alternatives'** (commonly shortened to 'Honest Broker') engages in decision-making, contributing knowledge and understanding alongside a range of other participants to expand and clarify the scope of choice available, and to converge collectively on an agreed way forward.

Whilst noting that the Honest Broker is the most useful for policy development, Pielke proposes that all four of his idealised roles have their place, and that climate scientists have the choice of which one to play and under what circumstances. He emphasises the critical importance of making the role clear to all concerned once a choice has been made. We observe that it is not necessary, or even desirable, for every climate scientist to fulfil every role, but the community as a whole needs to establish a division of labour that satisfies societal needs.

Pielke also points out the danger within any of the four roles of 'stealth' issue advocacy – when a researcher either knowingly or unwittingly advances a political outcome when apparently focusing solely on science. We discuss later how this might be guarded against.

Considering each role in turn we make the following observations:

The Pure Scientist is the role of greatest interest to the majority of researchers. It is usually what attracted them into a research career in the first place. It fulfils their job satisfaction (primarily curiosity about some aspect of the natural or social world), defines their self-image and self-esteem, and provides the means to gain esteem from the members of an invisible college of their peers. Given the pressures of fundraising, the tortuous and uncertain nature of scientific investigation (usually these days requiring organizationally complex and demanding collaborations), the requirement to maintain a flow of high-quality publications, to maintain skills at the frontier of their specialism and to keep up with an ever-growing volume of relevant published material, as well as the additional demands of teaching, supporting peer-review, and participation in a multitude of committees and panels, many researchers consider this to be the limit of their capability and obligation.

The Science Arbiter role is problematical within climate science, since individual practitioners are generally expert only in a narrow specialism. So vast is the range of research topics encompassed and relevant to key conclusions that few, if any, are sufficiently well-versed and authoritative to be able to respond to the full range of general questions. This is reinforced by the academic taboo of straying outside one's direct area of research expertise. As a result, the Science Arbiter function is commonly performed by a committee or panel composed of an appropriate range of experts, backed up by access to a wider diaspora of specialists. Examples include the UK Committee on Climate Change[25], and the 'synthesis' projects of the international Global Change research programmes[26, 27].

Within the climate science community there is a small but prominent group of individuals (James Hansen for example[28, 29]) who have adopted the mantle of Issue Advocate using their status as scientists, or invoking their specialist expertise, to justify and pursue a specific cause. In doing so they court a loss of authority and trust as their audience consciously or unconsciously makes judgements about their impartiality, freedom from bias, and motives, and discounts their commentary accordingly. Most natural scientists are instinctively reluctant to adopt the role, recognising the risk to their scientific standing. This is despite their right as citizens to express an opinion, provided they acknowledge that they are doing so, and provided they make clear the limits of the knowledge upon which the opinion is based, and the inevitability of personal bias. Some argue that a climate scientist's specialist knowledge and perspective, acquired at the taxpayer's expense, constitutes an obligation both to draw attention to issues they judge society needs to be aware of – as an opportunity or threat – and to offer their personal view on the most appropriate response[30, 31]. We will return to this issue in Section 4.2, especially regarding the legitimacy and efficacy of scientists publicly expressing judgements.

The Honest Broker function draws a parallel to that employed routinely in organizational decision-making. A standard approach involves a sequence of steps: defining the issue, identifying the options, identifying the evaluation criteria, describing each option, comparing and scoring the options, identifying the discriminators and summarising the trade-offs. For the decision-makers to be confident in the choice made, they need to be convinced that all possible options have been explored, and that the analysis has been thorough, fair and balanced. The process can be straightforward – even mechanistic – when addressing 'tornado politics'; it is more challenging when confronting 'abortion politics', when interests, values or beliefs distort the discussion or are a source of conflict and disagreement. Under these circumstances the role of the decision-making body is to make a judgement, recognising that it may be impossible to satisfy all participants or to deliver a perfect outcome, and noting that pressures of political expediency may seek to prevail. Openness, transparency and fairness then become critical factors in the public acceptability of the decision. Citizens' juries provide an example[32].

Given that the Honest Broker role is a crucial element of the co-production model, it would be reassuring to find it a commonplace activity for climate scientists, and one in which they have built of a corpus of experience and agreement on best practice. Although there are notable examples, such as the US Global Change Research Program's National Climate Assessment exercise[33] and US National Oceanographic and Atmospheric Administration's Regional Integrated Sciences & Assessments program[34,] a co-production approach with the characteristics described by Hulme, in which climate scientists participate with other stakeholders as Honest Brokers, remains the exception rather than the rule. It could be argued that the Chief Scientific Advisors (CSAs) and science support staff within UK Government departments play a version of this role. However, whilst the existence of the CSAs represents an important recognition of the value of expert scientific advice at the core of government, their contributions to decision-making and policy formulation, and the fora within which they operate, are necessarily neither transparent nor inclusive. In practice, the influence of the CSAs and the efforts by climate scientists to work with stakeholders to help them interpret the results of climate research (e.g. in the exploitation of the UK Climate Projections 2009[35, 36]) correspond to an enhancement of what is at root the linear approach. The relatively limited adoption of the Honest Broker role thus appears to derive at least as much from of a lack of opportunity, given established, non-co-productive ways in which public policy is actually addressed, as it does from a general preference amongst climate scientists to focus on their Pure Scientist task.

1.4 Thoughts and Observations on the Pielke Roles

Kevin Curry and Susan Clark[37], in a review of Pielke's book, applaud the helpful framework it provides, but express disappointment that the Honest Broker role is not developed more fully. They regret the absence of specific examples, especially those demonstrating superior decision-making. Sheila Jasanoff[38] points out that a study of the performance of senior science advisors reveals that they are prone to making value judgements within the decision-making process, and that these have a critical influence on the choice of facts and disciplines judged to be relevant, on when new knowledge is reliable enough for use, on which dissenting viewpoints deserve to be heard, and on when action is appropriate. This reinforces Pielke's concerns about 'stealth advocacy', and the difficulty, or even impossibility, in practice in fulfilling the idealized Honest Broker role (see also Sarewitz[23]). To expose and counter such tendencies places a premium on process, and raises fundamental and challenging issues of governance: Who has legitimate authority to decide what on behalf of whom and on what basis? These questions lie beyond the scope of this document, but are of significant consideration for policymakers and the public.

Here we draw attention to an omission from Pielke's idealized functions – a fifth idealized role – that of engaging with society to draw attention to and discuss the results and implications of the research that it has funded. We adopt the title 'Science Communicator', and note that it includes the task of raising the alert if the implications of a piece of research point to a significant societal threat or opportunity. The view that scientists have a basic responsibility to communicate what they are doing, why they are doing it, and what results they have obtained is a basic tenet of the Science & Society movement that has developed over recent decades. It is enshrined, for example, in the Research Councils UK *Concordat for Engaging the Public with Research*[39]. In the case of policy-relevant research, particularly if it has been declared as such as part of the justification for funding, our view is that the communication and explanation of results is not an optional role: it should be an obligation. Climate science is sufficiently technical and nuanced that it does not readily explain itself, and Sarewitz[23] points out that when scientific results bear on policy decisions, scientists are embroiled in the policy process whether they like it or not, and carry authority and responsibility in "advocating one fact-based interpretation over another".

To do so represents a challenge, since most scientists are practised at communicating complex material to other experts using technical language and an 'objective–method–results–conclusions' format. They assume extensive contextual knowledge, a familiarity with the technical language and mode of discourse, and tend to stick rigorously to professional norms concerning the need to express uncertainties, to avoid presenting material outside their immediate area of expertise, and to avoid expressing judgments or opinions. Few are practised at translating their message into language suitable to inform a panel of experts in other fields, or in the day-to-day language and a storyline targeted at a general audience, let alone the concise form suitable for a journalist. We discuss this further in Section 4.2. Even fewer are confident or capable of participating in the rough and tumble of live public debate, where the rules of engagement may be far from academic (the debate asymmetry referred to earlier). Those who do so court loss of public and professional esteem if preceived to lose the argument, and can find themselves the target of vituperative personal attack. Not surprisingly, the majority prefer not to take the risk.

Regarding the current norms and practices of climate scientists, we echo Pielke's observation that "with some notable exceptions, most scientists, including social scientists, are simply unaware of the understandings of the scholarly community who study science in society"[8]. The body of salient knowledge and insight is, by and large, neither taught nor discussed. As a result, confusion tends to reign over the roles of climate scientists in decision-making, and such interactions as do take place are developed mainly on an individual basis and through trial and error – providing further evidence that Lubchenco's "vigorous exploration of the relationship between science and society" is very much unfinished business.

1.5 Why Does the 'Technocratic'/'Linear' Model Persist?

We have seen that despite its failings, and despite some encouraging examples to the contrary, the technocratic model continues to prevail. This may simply result from inertia following its success as the *modus operandum* during the Second World War (a textbook case of 'tornado politics') combined with a lack of recognition on the part of climate scientists that their circumstances differ (i.e. that climate science issues correspond to 'abortion politics'). It is compounded by the general paucity of interactions between climate scientists and political scientists with expertise concerning the interplay between science and policy.

But are there deeper reasons? One possibility is that for most Pure Scientists the policy relevance of a piece of science is perceived as a downstream output – almost an afterthought (or even a chore[40]). This may in turn derive from a tendency of the human mind to interpret the world in terms of linear 'cause and effect' and to seek simplistic solutions to complex problems. This was the view of Jay Forrester, who in the late 1950s advanced the idea that our thought processes are ill-adapted to addressing the behaviour of complex, multi-loop feedback systems[41], to which the co-production model more closely corresponds.

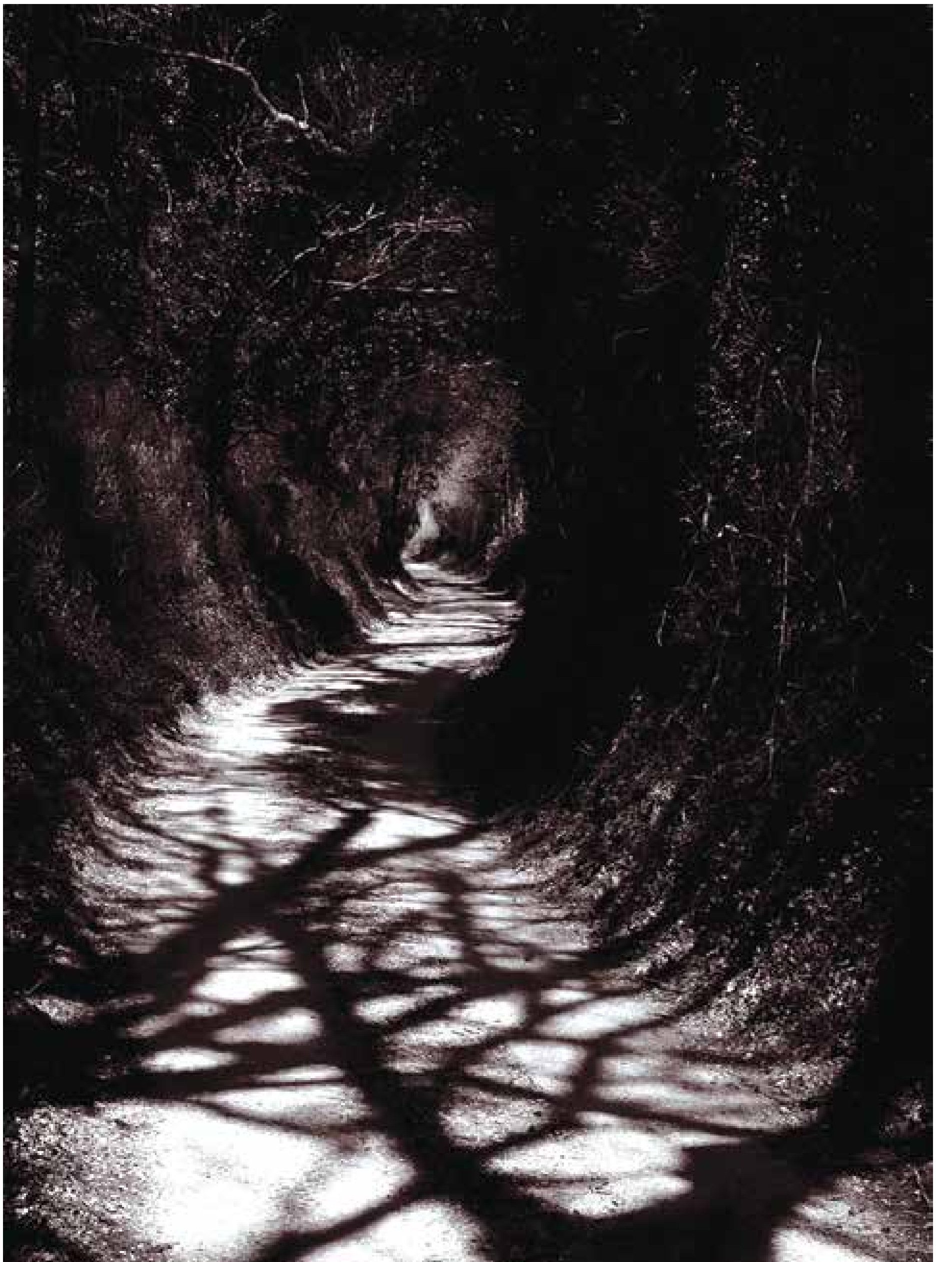
A less flattering explanation is offered by Richard Lindzen[42], who suggests that the self-interest of scientists, university administrations and government bureaucracies, combined with the pursuit by advocates of a political agenda, and the desire of politicians to avoid responsibility for hard and potentially unpopular decisions, leads to a situation in which all conspire to promote science as a source of political authority rather than a mode of academic enquiry (i.e. the technocratic model). He describes a triangle of interactions (the 'Iron Triangle') between politicians, scientists and agenda-driven advocates, in which politicians benefit by procrastination (waiting for research outcomes and greater certainty) whilst appearing to take action (commissioning the research), scientists benefit from the funds (the 'Iron Rice Bowl'), attention and prestige, and the advocates benefit from the production by the scientists of a never-ending source of new material (work in progress) which can be cherry-picked and exploited to suit their ends. Sonja Boehmer-Christiansen interprets the course of climate science, climate policy and energy policy within the UK in the decades of the 1970s and 1980s according to this prescription[43].

Although these may be harsh characterizations, they contain some elements not easily dismissed. There is no doubt that the policy relevance of their subject matter has increased the climate science community's funding, standing and access to power and influence. And whilst the community has been active in drawing attention to the flaws in the arguments put forward by those that reject or downplay climate change (e.g. via websites such as Skeptical Science[44] and RealClimate[45]), it has been less evident in denouncing alarmist misrepresentation of climate science. This might suggest a tendency, conscious or not, to sustain the political imperative. In this vein, Sarewitz asserts that errors in the IPCC reports have consistently been in the direction of greater threat[46]. However, this may reflect a bias in the process by which the errors have been exposed – by the dismissive community – rather than in their actual nature. Kenyn Brysse et al[47] and Stefan Rhamstorf et al[48] make the opposite case: that the climate science community tends to "err on the side of least drama".

Whatever the underlying motivations, the interaction between scientists, advocates and policymakers in practice has served to reinforce the linear approach, to the detriment of science, public policy and decision-making. To move to the co-production model, in which scientists take their place with other experts to inform decisions by those assigned by society with the authority, responsibility and accountability to do so, will require determined changes in their mode of engagement by all parties.

1.6 Summary

In this section we have explored the relationship of climate science to policy and the corresponding roles of climate scientists. We have identified a mismatch between established practices of climate scientists and the needs of the 'new era' of policy relevance, and an unhelpful disconnect between climate scientists and academics who study how science and policy interact. Notwithstanding examples to the contrary, we have drawn attention to the general persistence of the technocratic (linear) model of policy formulation, despite its inappropriateness, and despite the existence of a putatively more effective, although less well-tested, alternative (the co-production model). We have offered possible explanations for this.
We have identified a fifth role of Science Communicator for scientists, in addition to those identified and described by Pielke. We have noted that an inevitable consequence of the linear approach is that climate science and climate scientists find themselves the target of unremitting controversy and attack. A key underlying source of this tension is disagreement over the policy options. A salient question, then, is how and why such disagreement arises in the first place. This we will address. However, it is useful first to explore the workings of the human mind, since this casts valuable light both on vulnerabilities of the scientific process, and on the societal reaction to complex, unwelcome and inconvenient scientific messages such as those delivered by climate science.



Photograph Joe Low

WHAT IS INSIDE OUR MINDS?

Chapter 2

KEY POINTS

- Rather than perceiving ‘objective truth’, our brains assign ‘meaning in context’ to information gathered from our senses – constrained by prior experiences, and social and cultural factors.
- Many commonly held preconceptions about how the human mind works are incorrect or incomplete.
- These include assumptions about perception, cognition, rationality, our attitudes to others, values, as well as reactions to fear, risk and uncertainty.
- Human cognition consists of two types of thinking: intuitive processes and reflective reasoning. Both operate together, but more of our responses are determined by intuitions than commonly appreciated: intuitions come first, reasoning second. More goes on in our minds than we are consciously aware of.

KEY POINTS CONTINUED

- Disagreement within climate discourse has more to do with differences in values and world-views, and by our propensity for social evaluations than it is about scientific facts. This in turn leads to disagreements over policy choices.
- Climate science contains enough complexity and ambiguity to support a variety of positions. Simply providing more facts will not resolve the disagreements.
- Findings from the social and behavioural sciences explain how people, given identical evidence, can come to opposing conclusions. They also provide an explanation for people's natural inclination to denigrate those who hold opposing convictions. Taken together these insights help to explain the contested nature of climate science.

2.1 Insights from the Mind Sciences: Relevance to Climate Change

In Chapter 1 we concluded that the functions of climate scientists are to reveal ‘objective truth’, achievable within certain limits, and to interact with society to stimulate and inform a rational co-produced public process determining how best to respond to the results and implications. The reliability of the scientific ‘facts’ and the trustworthiness of climate scientists were taken as given. Yet, in reality, how people communicate and perceive scientific findings, and how climate scientists are regarded by their audiences, are influenced by prior knowledge, opinions, habits, values and world-views[49].

People across the spectrum of opinion on climate change share the same propensity to find reason to discount those with whom they disagree. Explanations range from ‘ignorance’ and ‘gullibility’ to ‘craziness’, ‘political motivation’ and greed for ‘power / influence / funds’. This tendency derives from what social psychologist Fritz Heider called common-sense psychology[50]: our minds automatically attribute intentions and character traits to explain the actions and opinions of others, and we construct – often speculative – narratives to make sense of their behaviour.

So what can a scientific study of minds and belief-formation add to those common-sense explanations we naturally generate? How can it help to communicate climate science better, and how can this knowledge defuse tensions in the ongoing public debate about climate policy?

In the following paragraphs we discuss research from neuroscience and psychology that illuminates these questions in two ways. Firstly, we explore the results of research into the communication of contentious issues. These provide a portal into what Dan Kahan calls an “evidence-based science of climate science communication”[51]. Secondly, we explore the motivations and psychological processes that lead people to take a strong public stand on a given issue, and hence result in divisions in society. These understandings open up ways to move the public discourse away from the sterile stereotypical clichés that are currently so prevalent ('alarmists', 'deniers', 'evil vested interests') to a conversation which is more respectful and constructive. On this topic, too, the report can only provide a portal, but references to further reading materials are supplied throughout the text.

The sections in this chapter are organized around common preconceptions about the human mind, which follow from our tendency to engage in common-sense psychology, or from dominant historical narratives about human rationality. We describe how these preconceptions have been subjected to experimental study, and how they are currently understood within different traditions in the mind sciences. Sometimes the results from these empirical studies have confirmed the original preconception. More often than not, however, they have demonstrated the need for alternative ways to think about the underlying issues. To give an example: several studies have shown that there is almost no relation between intelligence (as measured by IQ or verbal ability tests) and an individual's propensity to consider arguments that contradict prior beliefs. Yet, these same experiments also showed that there is a strong relation between intelligence and the ability to defend one's own point of view. In other words, intelligence or analytical ability does not protect from the risk of so-called 'myside bias', defined as the propensity to only see one's own side of an argument[52]. These findings run counter to an intuitive explanation that people of any disposition may be tempted to employ (e.g. 'people who disagree with me must be irrational or unintelligent'). Instead, they call for a richer set of explanations for why equally intelligent and well-meaning people, evaluating the same facts, come to opposing convictions. Such explanations start with how our brains impose meaning on the sensory stimulation coming from the world around us.

2.2 Perception: 'Meaning in Context'

"The observer never sees the pure phenomenon with his own eyes; rather much depends on his mood, the state of his senses, the light, the air ... and a thousand other circumstances," wrote Goethe in *Empirical Observation and Science*[53]. Yet the common assumption was then, and often still is, that the senses represent the world truthfully, with some minor 'noise' introduced by the circumstances of the observer.

Preconception 1: The senses provide an accurate view of the world

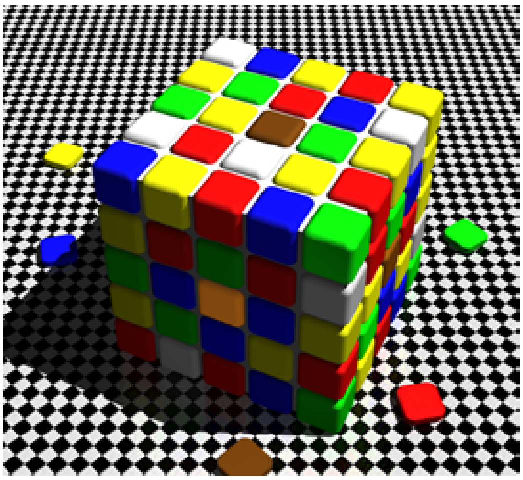
The view from perceptual neuroscience and psychology:

- The brain assigns *meaning* to sensory stimuli in a context of *prior knowledge*.
- Prior knowledge incorporates *evolutionar*y and *developmenta*l elements.
- Perception is also influenced by factors such as mood, emotions, and social context.

Despite our daily experience to the contrary, our sensory systems are incapable of truthfully representing reality. The information the eyes provide to the brain is, by itself, insufficient to resolve the true state of the world. For example, light is captured in a way that conflates aspects of reality such as the illumination and reflectance of surfaces, which cannot be separated by further stages of sensory processing.

How then are we able to generate perceptions that appear to be confirmed by successful interactions with the physical world? We do so by applying prior knowledge in order to select which one of the possibilities is the most likely given the current stimulus. This prior knowledge derives from our lives' histories, from brain development and learning, and from evolutionary history – the way natural selection has shaped the sensory processing systems in the brain. The selection pressures on these sensory systems have not favoured an unbiased search for the truth. Rather, our brains use their history of perception to infer solutions that have proven to be, on average, the most likely to benefit us and to keep us alive.

We might assume that what is useful in keeping us alive cannot be that different from what is 'out there'. That this is not necessarily true can be seen in Figure 1. Two physically identical patches look quite different depending on their spatial context. Rather than seeing a 'true' colour, the brain infers the colour based on the brightness and hue of the surrounding surfaces. Knowing that the patches are identical cannot override the powerful perception that they appear to be different[54]. The evolutionary benefit of perceiving intrinsic colour is fundamental to survival (for example in distinguishing between a venomous and a harmless reptile observed under various lighting conditions.)



(by R. Beau Lotto)

Figure 1: The central tiles in the upper and front surface of the cube appear very different in colour (brown and orange), but they are physically the same. Knowing that this is true cannot override the perception.

Needs, goals, motives, and our physical and emotional state also affect basic perceptual judgements. For example, desired objects appear closer than undesired ones[55], and children from poor socio-economic backgrounds estimate the size of coins to be larger than wealthier children[56]. These illustrations, and many more in the study of perception, demonstrate that our sensory systems do not attempt to provide an accurate view of reality. Rather, our brains assign meaning to sensory stimuli, constrained by context that derives from our immediate physical and mental state, developmental history, social and cultural environment, and the evolutionary history of our species (Figure 2). This process of assigning 'meaning in context' starts with the most fundamental building blocks of perception, but extends to all other aspects of brain operation. Most of the time our brains assign meaning automatically and quickly, as we will discuss next.

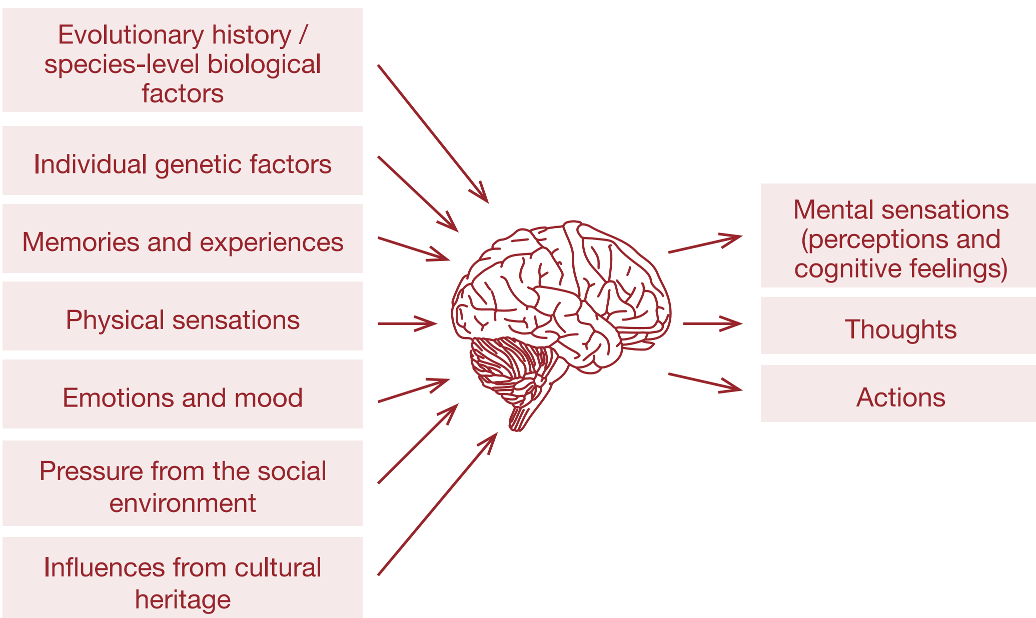


Figure 2: Factors that contribute to mental states, beliefs, thoughts and actions (adapted from Burton[57])

2.3 Cognition: Intuitions and Reasoning

Even if sensory perception cannot provide an accurate view of reality, one might argue that human reason is, or ought, to be unaffected. This is one of the assumptions of the 'rationalist' tradition which has its roots in the enlightenment thinking of the 17th and 18th century: that through reason we can eliminate error and arrive logically at truth. The ideas of rationalism contributed to the scientific and industrial progress of the last 200 years, but its influence in society extends further, to the degree that a language of rationality permeates the public discourse on climate change. Many commentators have claimed the rational high ground, from Al Gore's *The Assault on Reason*[58] to Nigel Lawson's *An Appeal to Reason: A Cool Look at Global Warming*[59]. However, the relationship between rationality and higher cognition – i.e. the way we use knowledge to make decisions, solve problems or come to new insights[vi] – is much more subtle than the rationalist tradition assumes.

Preconception 2: Higher cognition is conscious and rational

The view from cognitive neuroscience and psychology:

- Higher cognition involves two types of thinking: *intuitive* processes and *reflective reasoning*.
- Neither is altogether rational or irrational, though both contain strong elements of rationality.
- More of our responses are generated by intuitions than commonly appreciated: *intuitions come first, reasoning second*[60].

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vi Examples of higher cognition are: solving a crossword or mathematical puzzle, making sense of the intentions of other people, or thinking about the morally right course of action to take in a given situation.

One of the converging findings across a range of research traditions in neuroscience and psychology[61–66] is that higher cognition involves two qualitatively different types of thinking processes:

- *System 1 intuitive processes* are autonomous and effortless. They operate outside of conscious awareness and do not require controlled attention. They generate fast, automatic responses that are advantageous in specific situations. They are also the wellspring for spontaneous creative thoughts and ideas.
- *System 2 reflective reasoning* is conscious, deliberative, effortful and requires controlled attention. It is flexible and can be applied to different problem domains. It underlies our capacity for abstract thinking, mental simulation and introspection.

System 1 consists of a multitude of processes that operate mostly non-consciously. We have little access through introspection to how a particular automatic response or intuition arose (though we can reflect on the response itself and consider its validity). Like the low-level perception processes described in Section 2.2, System 1 processes have been shaped by their utility for survival. They are mentally efficient and ecologically rational; that is, in the context in which they evolved, the responses are, on average, advantageous to survival. Because of their adaptation to specific contexts, the responses of System 1 are often biased towards certain outcomes, favouring one set of responses over others. In his book *Thinking Fast and Slow*, Daniel Kahneman describes them as “a system for jumping to conclusions”. They work well “if the conclusion jumped to is likely to be correct, and the costs of an occasional mistake acceptable, and if the jump saves time and effort”. But they are risky “when the situation is unfamiliar, the stakes are high, and there is no time to collect more information”[62].

System 2 appears to be a single system. It is slow in comparison with System 1, and requires access to limited cognitive resources. For this and other reasons, System 2 reasoning is limited in its ability to override System 1 intuitions. It would therefore be incorrect to equate System 2 with rationality: in many circumstances it is used to rationalise intuitions rather than to analyse them in a rational manner. In his book *The Righteous Mind: Why Good People are Divided by Politics and Religion*, Jonathan Haidt uses the metaphor of an elephant (intuitions) and a rider (reasoning), where the rider has evolved to serve the elephant, and has only limited control over its direction[60].

All thinking involves a combination of intuitive and reflective cognition, rather than cognition derived solely from System 1 or 2. We quickly see a solution to a problem, have an intuition that a proposition is true or false, or decide that someone can be trusted or not. This initial intuition may be accompanied by a search for explicit reasons to support or override it. The recognition that our thinking is dominated by autonomous processes that may or may not bear deliberative review is an important part to understanding our reactions to climate change. These insights apply as much to lay responses to the science and policy options, and to their judgements about the trustworthiness of scientists, as they do to scientists' own framing of the science and participation in the public debate. We will return to this on numerous occasions below.

Preconception 3: Cognition is separable from emotion

The view from cognitive, affective and social neuroscience/psychology:

- Emotions are essential for cognitive decision-making in everyday life.
- Cognition itself has an emotional component: intuitions have an associated *feeling of rightness.*

A further assumption of the rationalist tradition is that reasoning is (or ought to be) independent of emotion. Affect, however, is an essential ingredient of cognition. People who suffer damage to certain frontal brain areas maintain their ability to solve analytical problems, but become poor decision-makers in normal life. They lack an affective signal that drives a preference for some choices over others. Based on reason alone, they can no longer come to a decision, even for simple questions such as when to schedule an appointment[67].

Cognition itself has an affective component. In other words, there is a ‘feeling of knowing’. Studies have shown that the act of retrieving a memory or seeing an intuitive solution to an analytical problem is accompanied by a ‘feeling of rightness’. The feeling may derive from how fast the memory or intuition comes to mind, or from a person’s beliefs about his/her skills in solving the task[68]. This feeling of rightness may interfere with people’s natural inclination to follow up an intuitive response with an effortful, reasoned analysis[69].

Opinions and beliefs can also have an affective dimension. Psychologists make a distinction between any proposition deemed ‘true’ or ‘real’ (an opinion), and those that have an affective, evaluative component (an attitude). For example, ‘climate is the long-term average of weather’ is an opinion which implies emotional neutrality; ‘climate change requires urgent action’ is an attitude which may carry negative affect (it may trigger worry in some, and angry rejection in others). Being challenged about the attitudes that one finds important will feel distressing, regardless of where one lies on the spectrum of views about climate change. This idea forms part of the theories of cognitive dissonance and motivated reasoning, to which we turn next.

2.4 The Formation and Strengthening of Attitudes

Preconception 4: Opinions and attitudes are formed by rationally judging evidence

The view from cognitive and social neuroscience/psychology:

- We readily accept evidence that fits with prior beliefs, but critically examine disconfirming evidence.
- Self-justification of our actions can drive people to a position of polarization.
- A challenge to our attitudes (a threat to our self image) triggers the need for self-justification.
- By being aware of this process we can deal more constructively with challenging situations.

We discussed previously how the brain assigns meaning to sensory stimuli in the context of prior knowledge, and how this affects the perception of even simple features such as colour, size and similarity. This 'meaning in context' principle is also applicable to cognitive information. Prior knowledge biases the assimilation of new information. People with strong convictions about an issue readily accept evidence that fits with their prior beliefs, but subject disconfirming evidence to critical examination[70, 71]. As social psychologist Thomas Gilovich wrote "for agreeable propositions, it is as if we ask ourselves: 'Can I believe this?' For disagreeable ones, it is as if we ask: 'Must I believe this?'"[72]. These distortions have serious consequences for the communication of climate science (and science more generally). When examined through the lenses of biased assimilation, climate science contains enough complexity and ambiguity to support a variety of positions, from overly alarmist to entirely dismissive. Simply providing more facts will not be enough to resolve the disagreements. Much depends on the social and value-based context in which the information is presented and processed, as we will see later.

Public attitudes about climate change have not always been so polarized. Crucial to understanding how they became so is the notion that, under certain conditions, behaviour drives attitude change. When there is a discrepancy between someone's actions and internal attitudes, this gives rise to a process of self-justification to bring the internal attitudes in line with the outcome of the behaviour (Haidt's rider justifying the actions of the elephant). Over time, this cumulative effect can lead from initial indifference to a position of strong conviction and polarization. In their book *Mistakes Were Made (But Not by Me): Why We Justify Foolish Beliefs, Bad Decisions, and Hurtful Acts* social psychologists Carol Tavris and Elliot Aronson compared this process of strengthening attitudes to a descent down the slopes of a pyramid (see Figure 3)[73]. A step off the tip of pyramid even if entirely unconscious amounts to an action (e.g. internalising some information or engaging in a conversation). Initially, the attitudes may be sufficiently weak that the direction of the initial step is random and even reversible. However, once that step has been taken it sets in motion a cycle of self-justification and further action. Each downwards step makes the continuation more likely. The further the descent the greater the commitment to a given stance, and the harder it becomes to retrace steps or to contemplate being wrong.

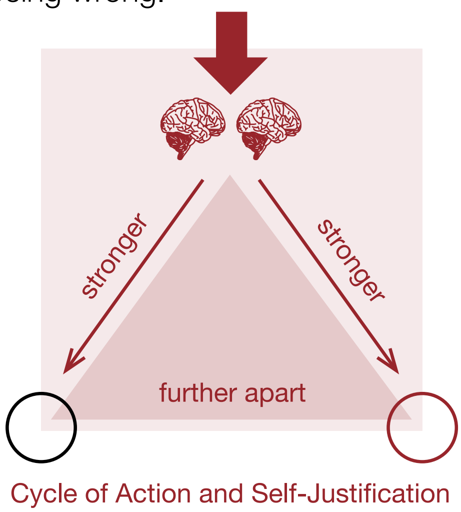

Figure 3: The 'pyramid' of increasingly stronger conviction and polarization

What drives people to the bottom of the pyramid? A key insight is that people strive towards internal[vii] consistency[74], particularly in the beliefs they have about themselves[75] (e.g. 'I am an intelligent, kind and competent person'). A challenge to our behaviour or attitudes acts as a potential threat to our self image ('How could I, an intelligent, kind and competent person, hold an illogical belief or have done something hurtful?'). It gives rise to 'dissonance', a state of discomfort and distress, which acts as a powerful motivating force to rationalize the offending evidence. It is thus because of the desire to be right in our beliefs about ourselves (and its opposite, the discomfort we want to eradicate when those beliefs are challenged), which puts us at risk of descending to the bottom of the pyramid. What counts as a threat depends on the circumstances of each individual, but, interestingly, the people at greater risk of becoming polarized over climate change are those who perceive themselves as intelligent and scientifically literate. The consequences of this were demonstrated by Kahan and colleagues[76], who showed that higher scientific literacy and numeracy resulted in greater (not smaller) division between different cultural groups assessing the risk associated with climate change. As we reported in Section 2.1, intelligence may help to support one's own point of view, but in itself it does not guard against 'myside bias'.

vii The 'internal' distinction is important; what may appear inconsistent or conflicted to an external observer may be perceived as consistent to the individual themselves.

2.5 Seeing Others

In the previous section we treated the formation of beliefs as occurring in isolation, but in reality we are strongly influenced by the attitudes of the people around us and the information they provide. Thus we can experience conflicting demands between our personal attitudes and those held by the individuals and groups we identify with. Crucial questions are 'Who do we trust?' and 'Who has authority to speak?'. The motivation to arrive at conclusions that are in line with a peer group is strong, but people are constrained in doing so by their ability to construct reasonable justifications for their conclusions[77]. This means that they may disagree with their peer group on some issues, and that even those who are very entrenched may sometimes change their minds if they no longer find 'reasonable justification' to support their position.

Two social strategies that people employ to justify their beliefs are to find support among like-minded people and to denigrate those with other convictions. Such motivations are evident in the – often very unconstrained – climate science discourse (supportive or dismissive) that takes place within the blogosphere and on Twitter. In this section we will discuss some of the mechanisms that contribute to the social attributions that, in the context of climate change, all too often lead to denigration. In the following section we will encounter some of the consequences of the second social strategy: finding support among like-minded people.

Preconception 5: We judge those we disagree with by the same standards as ourselves

The view from social and evolutionary neuroscience/psychology:

- We tend to explain our own actions more positively than those of other people.
- We use intuitive cognitive processes to judge the trustworthiness of people we engage with.
- Such processes are negatively biased in situations where we are not directly interacting with others.

In his book *The Social Animal: The Hidden Sources of Love, Character, and Achivement*, journalist and commentator David Brooks condensed 70 years of social attribution research into one sentence: “We judge ourselves by our intentions, our friends by their behaviour, and our enemies by their mistakes”[78]. This fundamental asymmetry is hard to avoid. It has led social psychologists to identify a number of self-biases in which we explain ourselves more positively than others. One such bias, the fundamental error of attribution[79], states that we tend to explain our own behaviour with recourse to external, contextual factors, whereas we are more likely to explain others in terms of fixed character traits.

Like general cognition, social cognition (i.e. thinking about the intentions and mental states of others) is more a product of intuitive, automatic cognition than we generally appreciate. It starts with infants as young as three to six months of age: they overwhelmingly prefer ‘nice’ over ‘nasty’ characters in simple puppet shows[80, 81]. As adults, our minds have sensitive mechanisms to detect when we are at risk of being cheated in situations of conditional social exchange (e.g. ‘If you accept a specific benefit, you must fulfil an associated requirement’)[82]. Such a social contract exists between academic scientists and the taxpayer: ‘If you accept public funding for your research, I expect you to behave in a competent, trustworthy and open manner’. These conditions make us highly sensitive to signs of improper behaviour, and it should come as no surprise that media stories alleging incompetence or dubious behaviour are readily believed by people who have no evidence to the contrary.

When combined with our own intuitive feeling-of-rightness and our view of ourselves as good, kind and competent, the common-sense way to explain those we disagree with is as ‘ignorant’, ‘unintelligent’, ‘gullible’, ‘mad’ or ‘evil’, when in reality their beliefs will to them seem equally rational and virtuous. Many people take deeply to heart these explanations, which originate in their intuitive social cognition. They see them as the core explanation for their disagreements with others, increasing their own feeling of ‘being right’. For people who have reached the bottom of the ‘pyramid’ (Section 2.4), the climate debate is thus more about social facts than about scientific facts. And over time, these social explanations lead to the stereotypes discussed previously.

The best antidote to these negative sides of our social intuitions is face-to-face personable interaction, under conditions of mutual respect, humility and empathy. Only those conditions will allow mending of relationships and more accurate judgements of the good intentions and trustworthiness of others.

2.6 Values, Cultures and World-Views

Preconception 6: The public debate about climate change is a debate about scientific facts

The view from social, moral and cultural neuroscience/psychology:

- Underneath the disagreement about facts lies a disagreement about *values*.
- The combination of climate science communication with value-driven policy proposals has led to a cultural polarization over climate science.

The societal division over climate change started from differences in values and moral intuitions generated by the suggested solutions for and policy implications of climate change. Solutions for climate change have often been framed in terms of ‘saving the environment’ and ‘saving the planet’. Whilst care for environment and planet are ethical concerns that can become concrete to some people, the association between rather abstract concepts like ‘planet’ and ‘environment’ and the ethical concern of ‘care’ is a learned association (i.e. a cultural value). It is not a universal ethical concern such as the feelings of care we may experience almost automatically when exposed to the suffering of individuals. Feelings of care follow from empathy – i.e. the capacity to feel what another person is feeling – which is another important aspect of our social brains[83]. Research has shown that even for people who make large lifestyle changes as a consequence of their concerns about climate change, empathy for the plight of other people may be a larger motivating force than care for the environment[84].

Solutions to combat climate change often appear to limit liberty (either of the market, or personal). Such proposals may clash with the values that some individuals hold important, and have contributed to the cultural polarization over climate change. Kahan and colleagues have conducted a number of studies that have shown these effects. For instance, cultural values and world-view (e.g. having an 'individualist' compared to an 'egalitarian' outlook) rather than scientific literacy, explain large disagreements in people's perception of risk posed by climate change[76] or their understanding of 'scientific consensus'[85]. Conversely, changing the 'cultural meaning' of climate science messages (for example by adding geo-engineering as a supplement to restricting CO_2 emissions) helps to offset cultural polarization over climate science itself[86].

As we noted in Section 2.5, the motivation to agree with the values of one's peer group is strong, but limited by the ability to construct seemingly reasonable justifications for one's position[77]. Therefore, rather than seeing these cultural values as absolute determinants, they can be seen as a biasing force. Specifically for climate change, the long-term framing of solutions that clashed with individual values made the initial step off the 'pyramid' (Section 2.4) for some groups more likely to go one way than the other.

Climate science communicators should be aware of and take into account such psychological mechanisms and biasing cultural world-views. Communicators should try to be sensitive to the different cultural meanings that their messages may have for different audiences[87]. Importantly, however, this process should itself be evidence-based. As Kahan et al have argued[88], collaboration between communicators and social scientists on evidence-based field experiments is the best means to improve the communication of climate science.

2.7 The Consequences of Fear Appeals

Preconception 7: Fear appeals are effective in the context of climate change

The view from health, social and evolutionary psychology:

- Fear appeals are effective when they point to specific dangers and are accompanied by solutions.
- In other conditions, they are likely to lead to avoidance and desensitization.
- Alarmist messages that fail to materialize contribute to the loss of trust in the science community.

Reports about climate change often focus on its potentially dire consequences – sometimes more so than is justified by the science. This may follow from the private concerns of the communicators, and from the preconception that communicating threatening information is a necessary and effective catalyst for individual behaviour change. But there is little concrete evidence for this. Threats and the fear they induce do act as a motivator for action, but only if specific rather than vague, and specific to the individual rather than impersonal[viii]. Also important is the availability of clear and specific information on how to avert the danger. Individuals need to have a sense of control, and feel that the proposed strategy is an effective way of resolving the problem[89], [90]. These conditions are almost all violated in the context of climate change[91]: threats are usually imprecise and far in the future; proposed solutions may seem costly and unattractive (e.g. large lifestyle changes) or too small to have an impact (e.g. changing types of light bulbs). In this context, it is possible for individuals to change their behaviour once they become convinced of the severity of the issue, but only as a

viii This has been shown by research in different areas, mostly in the communication of health issues.

determined and conscious decision, usually driven by a set of internalised values (see Section 2.6), rather than as an intuitive response to avoid danger.

Fear appeals relating to climate change are not only poor catalysts for behaviour change, but also have harmful consequences. Strong fear appeals with low efficacy to avert danger can generate defensive avoidance ('This is too scary to think about') or reactance ('They are trying to manipulate me')[90]. When they are initially accepted, they can generate a state of prolonged worry and anxiety. Over time this worry changes to numbness, desensitisation and disengagement from the issue altogether.

Alarmist messages have also played a direct role in the loss of trust in the science community. The failure of specific predictions of climate change to materialize creates the impression that the climate science community as a whole resorts to raising false alarms. When apparent failures are not adequately explained, future threats become less believable[92, 93]. Moreover, it is likely that they put our sensitive cheater detection mechanisms (see Section 2.5) on high alert and make allegations of personal gain more believable. Media reports that suggest incompetence (e.g. the focus on errors in the IPCC's Fourth Assessment Report) or improper behaviour (e.g. 'Climategate') then resonate more strongly with parts of the public because they turn the question 'Must I believe this threatening information that fails to materialise?' into 'Can I believe that the communicator is trying to scare me for his/her own personal gain?' The attraction of the second question is understandable for those who do not know anyone personally within the climate science community, or who do not have access to other information that allows them to establish the trustworthiness of the communicators.

2.8 Risk and Uncertainty: Scientific versus Intuitive Notions

Preconception 8: Risk and uncertainty are unambiguous concepts

The view from cognitive, social and evolutionary neuroscience/psychology:

- The scientific notions of risk and uncertainty are likely to differ significantly from intuitive notions.
- People may judge risks differently, dependent on emotional, social and cultural factors.

The concepts of ‘uncertainty’ and ‘risk’ permeate the climate change discourse. Scientists have endeavoured to define formally what they mean by the terms, and to quantify and communicate them clearly[94]. However, uncertainty (as a scientific concept) and risk analysis (e.g. as used by insurance companies) are products of our System 2 cognition. They represent sets of analytical rules and procedures developed to aid decision-making in an unpredictable world. Over years of professional experience, scientists and risk analysts have internalised these practices and come to associate them closely with the meaning of the words. Outside of this context, ‘uncertainty’ and ‘risk’ generate intuitive responses that differ from their analytical counterparts.

Risk perception as automatic System 1 process has both a cognitive and affective component. Experiments have shown that humans can quickly and reliably detect when the violation of a precautionary rule leads to a situation of danger (‘When you drive, you should wear a seat belt’)[82]. The adaptive advantages for such intuitive risk perception mechanisms are similar to those for cheater detection in social exchanges (see

Section 2.5)[ix]. Risk also carries affect, as expressed in the idea of 'risk as feelings'[95, 96]. Negative affect, such as fear, amplifies risk judgements; positive affect and anger both attenuate risk judgements[97]. How much risk individuals perceive depends on the contextual factors shown in Figure 2: personality, mood, values and world-views all have an impact, as has been well established in the context of climate change[76, 98].

Unlike risk, there is no known equivalent System 1 cognitive process for the perception of uncertainty. Rather, uncertainty is thought to be a mental and affective state characterised by 'not-knowing', by a lack of the feeling of rightness discussed in Sections 2.3 and 2.4. Little is known about the cognitive aspects of uncertainty. What is important to note here is that for those who have not internalised the formal, scientific notion, it is natural to substitute it with something we all have experience of: i.e. the feeling of uncertainty. The language of uncertainty can thus have different effects on different audiences. Those who are motivated to dismiss the science read it as fundamental doubt ('Scientists don't know anything'); activists may react to it angrily ('Why are they speaking about uncertainty when my feeling of certainty tells me we need to take action?'); and decision-makers may react with frustration ('Please resolve the uncertainty so we can take decisions').

This distinction between lay and expert perceptions of risk and uncertainty does not imply an inability to understand these concepts in the same way. Rather, it is crucial for the scientific community to understand that the way they have internalised their System 2 processes in their own conceptions of risk and uncertainty cannot readily be carried across to non-specialists by mathematical definitions. Because we have System 1 intuitive processes for the perception of risk ('risk as feeling') the formal concept of risk ('risk as analysis') is probably most easily translated to people's intuitive understanding – with the proviso that the level of risk different people will perceive in the same situation will be coloured by their emotional state,

ix The System 1 processes for detecting the violation of precautionary and social exchange rules are likely to be distinct, as selective brain damage may lead to impairment in one domain but not the other.

cultural values and world-views. We will return to the preference for the language of risk over uncertainty in Section 3.10.

2.9 Discussion and Summary

In this section we have explored the workings of the human mind and identified some implications for the communication of climate science. Scientists are trained to investigate aspects of the world around them. Some do so through the application of pure thought, whilst others use instruments to observe or measure, or computer models to simulate, explain and predict. In each case, a crucial skill is the knowledge and understanding of the 'tool' they employ sufficient to distinguish 'truth' from 'error', manifested, for example, as flawed versus correct logic, signal from noise, or spurious artefact from genuine result. So it is ironic that so few natural scientists are knowledgeable about the workings – and limitations – of the most basic tool they deploy: their mind.

We have seen in this section that many common preconceptions about the workings of the mind are misleading or incomplete. Psychologist Steven Pinker, commenting on the work of Kahneman, observed: "Human reason left to its own devices is apt to engage in a number of fallacies and systematic errors"[99]. Scientific researchers need to be acutely aware of this, recognising the implications it has for their ability to achieve the logical correctness, impartiality, open-mindedness and balance which they seek. Humility and constant introspection ('seeing yourself see'), driven by awareness of the issues, can provide a partial safeguard. As Pinker also noted: "If we want to make better decisions in our personal lives and as a society, we ought to be aware of these biases and seek workarounds. … We have the means to overcome some of our limitations, through education, through institutions, through enlightenment".

In practice, it is the organised scrutiny within the scientific process that exposes the inevitable flaws and errors of scientists' work. We discuss this further in Section 3.5. At least within science, that process, imperfect as it may be, provides a methodology, as well as an aspiration and commitment, to weed out error and converge on 'objective truth'. Contributions to the discourse that are not subjected to an equivalent process should be weighed accordingly.

To many scientists, the recognition that their mind focuses on generating meaning in context rather than an ever-more truthful image of reality can be a revelation. But once this is recognized, along with the other insights discussed in this section, many features of the lay reaction to the results and conclusions of climate science can be understood. This is especially so once the roles of the emotional response to distressing news (fear, guilt, despair), the reaction against a threat to deeply held values of ideologies (e.g. a belief in individualism, and a related antagonism towards regulation and state intervention) are taken into account[100]. The messages from climate science are far from neutral in these respects, and so while some individuals may be galvanized into action, others experience a backlash of defensive avoidance or rejection, enhanced by the powerful need to feel right not wrong (and hence to rehearse and perfect arguments that justify this), and the tendency when stressed to seek someone to blame. For a climate scientist to connect with an audience, their approach needs to take these realities into account. We will return to this in Chapter 4.

Firstly though, we investigate the real-world performance of scientists and discuss how it contrasts with widely held mythology. We then consider how lessons from the world of business, notably the concept of 'brand DNA', can illuminate vulnerabilities of the public standing of climate scientists and climate science.

Photograph Joe Low

STRENGTHENING THE PUBLIC STANDING OF CLIMATE SCIENCE

Chapter 3

KEY POINTS

- Whilst scientists are highly trusted, they are held to overly idealised and unrealistic expectations of behaviour.
- The climate science community is very broad and lacks a coherent unified voice.
- Climate science is complex, and its conclusions are unwelcome, inconvenient and contested. It cannot be easily rendered into simple truths.
- The concept of ‘brand DNA’ provides a helpful means of identifying ways to strengthen the coherency and credibility of climate science.

KEY POINTS CONTINUED

- The internet offers opportunities for greater transparency and public participation in climate science. The quality and value of the discourse already under way within the blogosphere would benefit from greater participation of scientific experts.
- One way for climate scientists to engage more with society and with policymakers is to encourage and inform discourse on tractable, ‘no or low regret’ ways forward addressing different benefits on different timescales, starting with the near term.

3.1 Scientists: Myth and Reality

Opinion polls reveal very high levels of trust in scientists. In the UK around 70% of people believe that scientists tell the truth, as opposed to fewer than 10% who do not[101, 102]. Since few members of the public have ever met a scientist[103], what is the mental image that results in such high regard? What are people's expectations?

Robert Merton, the pioneer of the sociology of science, characterized the scientific ethos as a set of cultural values and norms which scientists internalize and use to guide their thoughts and actions[104]. He summarized these as Communalism, Universalism, Disinterestedness and Organised Scepticism[x]. A substantial literature has explored and expounded upon these ideas, often challenging the degree to which they reflect reality. For example, Michael Mahoney[105] extended Merton's concepts, identifying six characteristics commonly attributed to scientists both by themselves and by the lay public:

- objectivity and emotional neutrality
- rationality – as evidenced by superior reasoning skills
- open-mindedness – as evidenced by suspension of judgement and willingness to change opinion
- superior intelligence
- integrity in data collection and reporting
- communality – through open and cooperative sharing of knowledge.

x Communalism equates to the common ownership of discoveries by which scientists relinquish intellectual property in exchange for recognition and esteem. Universalism holds that claims to truth are evaluated in terms of universal or impersonal criteria. Disinterestedness is defined in terms of a passion for knowledge and a selfless concern for the benefit of society. 'Organised scepticism' requires that all ideas and results are tested via a rigorous, structured community scrutiny.

Considering objectivity first, Mahoney cites a number of historical instances in which scientists' perceptions have been influenced by their expectations. One example is the illusory perception of canals on Mars, which arose as a result of optical flaws in early telescopes, but persisted long after these had been overcome. He suggests that such confirmation biases may be common "particularly when there is a clear expectation, ambiguity in the data, and a heavy reliance on the human as an instrument of observation". Biases creep into experimental design, constituting a form of motivated reasoning. He points out: "Like other humans, scientists tend to associate with other people who share their views", leaving them vulnerable to 'group-think' and paradigm lock-in, as we saw in Section 2.5, and as discussed in depth by Thomas Kuhn[106].

On emotional neutrality, Mahoney notes that scientists are seldom impassive in their reactions to their work, and that: "The thrill of discoveries, positive results and personal success is thus accompanied by the (occasional) agony and frustration of anomalies, negative results and personal failures." Since cognition cannot be separated from emotion (Section 2.3), it follows that scientists' thinking is vulnerable to emotional influences. Indeed, a strong emotional drive may be essential for scientific creativity and progress[107].

But a lack of emotional neutrality on the part of individual scientists does not invalidate science. Karl Popper observed that: "It is not the objectivity or detachment of the individual scientist, but of science itself (what may be called 'the friendly-hostile cooperation of scientists' – that is, their readiness for mutual criticism) which makes for objectivity"[108]. We will discuss this further in Section 3.5.

For each of the other five characteristics, Mahoney concludes that under scrutiny "the image has not fared well". Pursuing the point, Joseph Ben-David[109] notes that when embroiled in controversies, scientists commonly abandon some or all of their ethical norms, for example acting with passion to further their goals, withholding findings in order to prevent advantage from competitors, and behaving "like litigants concerned more with putting together a convincing case than with the ultimate truth". Mike Mulkay concluded that Merton's norms should be seen less as a description of science practice, and more as "vocabularies of justification"[110, 111].

Given these realities, it is perhaps surprising that the myth of rational, impartial and emotionless purity retains such a firm hold on the self-image of the science community, and on the view from the outside by a generally admiring public. The high cultural ideals and norms of science represent a state of perfection constantly striven for, but hard to achieve. This follows directly from the insights of Chapter 2, and it underscores the need for active critical reflection and humility ('How do I know? Could I be wrong?') by scientists – and equally by those who accept, and those who dismiss, their results. Public confidence and trust could be enhanced by making such 'active critical reflection' transparent and open.

A strong public backlash is to be expected if a mismatch is exposed between expectations and reality. A salutary example is provided by the public dismay and loss of confidence following the release in 2009 of emails from the University of East Anglia's Climate Research Unit, which cast the behaviours of leading climate scientists in a poor light ('Climategate')[112–118]. We will return to this, noting here that it demonstrates the risk to the reputation of climate science and the regard for climate scientists not only of questionable practice, but also of allowing an overly idealised and unrealistic expectation to take hold and endure.

3.2 What Can We Learn from Branding?

We have seen that public regard for climate scientists is strongly influenced by how they are observed to behave. It is also affected by what they say. The situation is analogous to that of the public reputation and level of trust in a business or organization, which is often addressed in terms of a 'brand'. The practice of branding has become highly sophisticated, and here we explore what climate science might usefully learn from its insights, recognizing that a social-marketing approach to 'selling' climate science *per se* is inappropriate[119].

A brand is a reputation: a public standing[120–122]. A brand concerns 'affect', corresponding to the thoughts and feelings generated automatically when people see or imagine these symbols. If there is a positive resonance, they trust the brand and accept its legitimacy and narrative. It is a way of telling a story: to unify, to stand out, to display an identity and self-image, and to connect. It is not a specific product, logotype or colour palette, however recognizable these may be.

Positive branding is not easy to achieve. A brand's positive associations can all too easily and quickly be destroyed by a negative behaviour or association[123]. Creating a clear, unified and wholly positive brand, robust against events, is challenging; re-establishing one that has been damaged is especially so. A brand achieves success by creating a promise. This results in an expectation. When experience matches – or even exceeds – the expectation, the degree of trust in the brand grows; it is seen to deliver on its promises. By consistently doing so, trust develops into loyalty and then even advocacy. Once the latter is the case, the brand no longer has supporters, it has 'disciples' spreading the word and building its reputation for it. The reputation is no longer what the brand says it is: it is what people say it is.

Many successful brands have created their reputation by standing for something very clear – sometimes referred to as the 'brand DNA'. They have built all aspects of their work around a singular understanding of their purpose (what they are for), their values (how they behave), their vision (what they are seeking to achieve over a period of time) and their core narrative (what they communicate). Crucially, everybody within the brand has to be behind these elements, and needs to be committed and effective at delivering them. To help drive the brand's reputation, every piece of communication that comes from it needs a coherence that creates an experience that is unified and consistent with expectations.

This is not to say that successful brands are robust against all eventualities. But when faced with a challenge they can defend themselves from a position of strength. They have confidence, because they know what they stand for and what they are seeking to achieve. They have the capacity to survive, and can even benefit from errors and misfortunes, because people judge brands on the way they handle a challenge, and are prepared to forgive the initial setback. Ultimately, brands create reputations by providing something people value, respect and regard. They make a difference, and by achieving this distinction, they prove their worth; they connect and build relationships.

In the following sections we use the insights from branding and the concept of 'brand DNA' to explore ways in which the public status and role of climate scientists can be strengthened.

3.3 Who Speaks for Climate Science?

We have seen that a consistent and persistent ‘brand DNA’, encompassing purpose, behaviours and core narrative, is important to sustain a positive public standing. This is especially the case in a world where trust in once-respected institutions has been deeply eroded. But to do so for climate science presents a fundamental problem, since it is currently impossible to identify who is a climate scientist and who is not. Whilst there are an estimated 30,000 ‘climatologists’ worldwide, the vast range of science that contributes to the overall conclusions of climate science (ranging from studies of the Sun to the economic behaviour of humans) leaves it virtually impossible to isolate the subset of researchers corresponding to the expert climate science ‘community’ (see also the related discussion regarding the ‘Science Arbiter’ role in Section 1.3).

Add to this the blurring in the public square of pronouncements by environmental activists, politicians, advocates, pundits, commentators and self-appointed experts from all walks of life, all scrambled by distortions and errors in the media reporting, and it is apparent that the answer to the question ‘Who speaks for climate science?’ is ‘More or less anybody’. Without a coherent voice, maintaining a narrative that expresses consistent purpose, values and core messages is not possible. The resulting inconsistencies undermine the basis for a productive public conversation, and open up vulnerabilities to public confusion and mistrust.

Importantly, the same does not apply to those who dismiss the messages and policy implications of climate science, who, whilst drawn from a heterogeneous array of individuals and groups, are unified by a common purpose: to stand against a narrative with which they strongly disagree. As a result, regardless of any explicit coordination which may take place[124], there is a natural tendency for their messages to converge on greater coherency.

What could be done to balance this asymmetry? Official bodies such as the National Science Academies, scientific unions, the American and European Geophysical Unions, societies such as the UK Royal Meteorological Society, conferences and occasional gatherings of scientists such as the Nobel Laureates have all issued 'authoritative' statements on climate change (such as the most recent publication, by the UK Royal Society and US National Academy of Sciences[125]). However, whilst these broadly agree on their core scientific messages, they differ in detail, are generally poorly judged for a lay audience, and are only loosely adhered to by individual climate scientists. Neither the voices nor the messages are coherent, consistent or accessible to lay audiences.

One way to overcome this would be to create a body tasked explicitly with engaging in the public discourse – or conversation – on climate science (essentially the Science Communicator role proposed in Section 1.4). A longer-term initiative would be to establish a professional body for climate science that would accredit its members – allowing the voice of climate science to be clearly identified – and would provide a means and leadership for the community to develop a new set of cultural norms, values, practices and narratives, better attuned to the world in which climate science now finds itself. Importantly, it would seek to define and oversee standards of performance in the manner achieved by other professional bodies. We will return to these ideas in Chapter 6.

3.4 Elusive Consistency

Even assuming a unified and coherent voice for climate science can be achieved, we have seen the importance of consistency in the message delivered. However, a variety of factors militate against this ideal:

Academic freedom: Academics fiercely defend their intellectual independence, and resist committing to an 'agreed' set of standardized messages and goals. Those who do speak publicly reserve the right to present differences in content, emphasis and approach – including the extent to which they advocate policy and express alarm and urgency.

Narrow focus: As we have seen in earlier sections, scientists are generally motivated to focus their efforts on their (highly fragmented and individualistic) Pure Scientist role, and many do not recognize or acknowledge the broader obligations of policy-relevant science, including the need to actively deliver a unified and coherent 'brand DNA' and message.

The exaggeration of doubt: Naomi Oreskes and Robin Conway, in their book *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*[124], document how the tobacco industry, when faced with irrefutable evidence demonstrating the deadliness of its product, sought not to challenge the evidence directly, but to convince the public that the science was unsettled. An internal memo read: "Doubt is our product since it is the best means of competing with the 'body of fact' that exists in the mind of the general public." They and others[126–128] provide extensive evidence that the use of dismissal and doubt to sabotage climate science is now a routine part of US politics, well-funded by vested interests and delivered via a variety of think-tanks and activists. Riley Dunlap and Peter Jacques, based on a study of over 100 climate-change-dismissive books, identify strong links to conservative think-tanks (although with evidence that the genre is becoming increasingly 'self-sustaining') and note that fewer than 10% undergo peer review, "allowing authors or editors to recycle scientifically unfounded claims that are then amplified by the conservative movement, media and political elites"[129]. Doubt in the public mind is also created by the intense focus of the media and dismissive voices on any errors in climate science documents. The result is to discredit the science overall and hence undermine confidence (e.g. media coverage[130], right wing blogs[131] and an alternative assessment[132] of the relatively few and easily corrected errors in the Intergovernmental Panel on Climate Change Fourth Assessment Report).

False balance: This concerns the confusion created in the public mind by media reporting in which a compulsion to tell ‘both sides’ of the story, combined with time pressure and lack of expert depth on the part of the journalist, results in the distinction between assertions and scientific ‘facts’ not being made clear, or when disagreement over unresolved scientific issues (‘work in progress’) gives the impression that well-established conclusions are also in doubt. Within the UK, sceptical voices were present in roughly one in five articles covering climate change in a three-month study period in 2009/10[133]. In a report prepared for the BBC Trust, Steve Jones concluded that the corporation was giving undue space to climate dismissive voices “to make statements not supported by the facts”[134]. BBC coverage of climate science in spring 2014 triggered similar complaints[135]. The impression of uncertainty generated in this way contrasts sharply with the widely expressed conclusion within the climate science community that human influence on the climate system is clear[136, 137].

Problematic consensus: It is known that people exposed to apparent disunity amongst scientists on global warming tend to feel less certain that it is occurring, and show less support for climate policy[138]. To counter this, a number of attempts have been made by scientists to demonstrate high levels of professional agreement – for example showing that 97% or more of the expert community are in accord on the core outcomes[139–141]. Unfortunately, seeking to convince in this way suffers a weakness – that scientific facts gain their legitimacy not from consensus, but by surviving the process of organized scrutiny (discussed below). The argument that the ‘consensus’ is not the result of a ‘vote’, but represents the aggregate of independent conclusions by thousands of experts, is open to question, since it assumes that each scientist has carried out ‘due diligence’ to evaluate critically the evidence upon which their position is based. To do so involves rigorous scrutiny of a host of results ranging outside their individual zones of expertise. In all likelihood, the majority of researchers simply trust the effectiveness of the scientific process, and within it, the professionalism, honesty and rigour of colleagues working in areas outside their direct expertise. This places a premium on the effectiveness of the science process in producing robust outcomes, which we consider shortly.

Alarmism: Climate change is often presented in the public discourse in apocalyptic terms[142,143]. This is in part due to the tendency of the media to seek a striking headline, partly due to genuinely concerned individuals expressing their fears, and partly a deliberate strategy by some to engage public interest. It also arises as a result of the difficulty scientists experience in delivering messages that are alarming without slipping into 'alarmism'. Gill Ereaut and Nat Segnit note that the alarmist climate repertoire is typified by "an inflated or extreme lexicon, with an urgent tone. … It employs a quasi-religious register of doom, death, judgment, heaven, hell, using words such as 'catastrophe', 'chaos' and 'havoc'"[144]. Saffron O'Neill and Sophie Nicholson-Cole conclude that although fear appeals have much potential for attracting people's attention, they are generally an ineffective means of motivating genuine personal engagement[145]. This is consistent with Section 2.7, in which the dangers and drawbacks relating to fear appeals were outlined. Unsurprisingly, the alarmist narrative has generated a powerful backlash, in which climate scientists, along with the media and lobbyists, are characterized as 'doom mongers' motivated by self-interest to feed false panic and mass hysteria[146, 147]. This contrasts strongly with the view noted in Section 1.5 that climate scientists have a tendency to "err on the side of least drama".

Ereaut and Segnit conclude from their study of how climate change is being communicated and discussed in the UK that:

> "The climate change discourse in the UK today looks confusing, contradictory and chaotic. For every argument or perspective, whether on the scale of the problem, its nature, seriousness, causation or reversibility, there is a voice declaring its opposite … It seems likely that the overarching message for the lay public is that in fact nobody really knows."

3.5 The Road to Objective Truth

The fundamental feature that distinguishes the outcomes of scientific enquiry from other explanations of the world around us – and especially from assertion, opinion and (ideological or other) beliefs – is the testing of the ideas and results through a process of rigorous, structured, community scrutiny ('organised scepticism'). The process takes a number of forms: informal critical discussion amongst colleagues and experts via correspondence or in departmental seminars, brainstorming sessions or the coffee room; line-management oversight and challenge; the process of peer review of journal publications; and discussion and challenge within the worldwide cohort of experts – sometimes hostile – via correspondence, published criticisms, and face-to-face at seminars, workshops and conferences.

Considering each in turn: local scrutiny can be patchy due to limits on the availability of specialist expertise. In any case, there may be a reluctance to share ideas or results prior to publication for fear of alerting a competitor lest they publish first. Line-management oversight of research detail is generally weak. Journal peer review provides an important filter that limits the number of flawed ideas and results in circulation – at the expense of rejecting some valid work. However, shortcomings of the process have been the subject of much academic investigation and soul searching[148–150], and have received heavy criticism in the blogosphere and elsewhere[151].

In practice, it is the scrutiny of published results by scientists worldwide, and over a period of time, that allows the evolving balance of confirmatory and disconfirmatory evidence to be weighed, discussed and, ultimately, decided upon. By this means a subset of results reported in the academic journals migrate from being interesting possibilities to becoming established 'fact' suitable for textbooks (noting that even long-established 'facts' are vulnerable to revision in the light of new evidence).

There is a general acceptance amongst scientists that, given 'sufficient time', despite its shortcomings and evident possibilities for improvement, Popper's "friendly hostile co-operation and … readiness for mutual criticism"[108] provide a structured route for new material to come into play and progress to become part of the body of accepted knowledge, at the same time affording reasonable protection against error and fraud. Certainly, conjectures and results not subject to such a process should be discounted accordingly.

However, in circumstances where the need (or not) to change the existing world order of energy production, finance and politics hinges on the results of science, and where these results are (unsurprisingly and rightly) questioned and contested, it is worth considering whether the science review process, in all the forms identified above, would benefit from further strengthening.

This should certainly involve greater openness and transparency about the derivation of specific results (e.g. by making the relevant data sets and analysis available online with appropriate metadata and explanatory text – as is increasingly the case), and possibly greater institutional engagement and vigilance. But it could also involve developing means to discuss, evaluate and explain the status of a given result using open fora via the internet (possibly through a form of 'Wiki'), formalizing the conversations carried out on existing blog sites of all persuasions, but mediated in a manner to maintain open-minded impartiality, rationality and critical thinking. The benefit would be the availability of a trusted and authoritative means to explore the basis upon which any given result has been derived, and to understand whether and why it remains 'work in progress' or has been superseded or vindicated. The cost would be the effort (and financial support) required to achieve this in a manner that was genuinely efficient, robust and trusted.

3.6 Mismatched Rhythms

We noted above the importance of allowing the peer review process to run its full course. But to what does 'sufficient time' correspond? It may only take a few minutes to spot an obvious flaw, yet, even with today's accelerated pace of activity, it may be decades before a deeply entrenched but erroneous paradigm is exposed and shifted. The rate of progress is constrained by the often substantial time taken to achieve a next step in testing (it can take decades to design, build, launch and operate a satellite instrument, or to prepare an ocean-going scientific cruise, or to develop and run a new computer model), or by the need to wait for time-dependent processes within the climate system to run their course.

Herein lie problems. Firstly, the timetables of decision-making and policy formulation can be significantly out of synchronism with crucial scientific evidence upon which they depend[152]. Under some circumstances, a 'decision pathways' approach may be possible, allowing decisions to be delayed as long as possible to take advantage of the best information available, and to allow for recovery if judgments subsequently prove wrong[153, 154]. In other cases, time pressure may force action regardless.

Secondly, timescales of months to years – or even decades – are incompatible with the 'instant' response times and attention cycles of the contemporary media, blogosphere and, frequently, policy formation. The intense emphasis on immediacy focuses public discussion on results or events too fresh for necessary critical assessment to have taken place. As a consequence, the lay public is exposed to an ongoing sequence of news stories that veer according to the latest turn of events, generating an impression of disorder and disarray. What is being witnessed in reality are glimpses into the process of scientific scrutiny – but this is rarely explained.

This lack of appreciation of the process of science provides advocates – including media outlets with strongly ideological or politicised editorial policies – the opportunity to cherry-pick results to suit a given agenda. Sequential cherry-picking can generate the appearance of a consistent narrative, regardless of whether or not it is scientifically sound. Refutations or clarifications by the science community, if they take place at all, occur days if not months after the initial story, when public interest has moved on.

3.7 New Forms of Scrutiny and Participation

The rise of the internet has introduced a further powerful dynamic. Anyone with access is free to participate in the scientific process. The reaction of the science community has been mixed. A small but growing number of pioneers has welcomed such interest (see for example Tamsin Edward's blog *All Models are Wrong*[155]). Some researchers have taken the opportunity to 'crowd source' intellect, skills and effort to assist with experiments, distributed-computing exercises and data analyses, and to engage the lay public in collaborative initiatives with experts (e.g. Myles Allen's climateprediction.net[156] and the Climate Change Collaboratory[157]).

Others, though, have reacted less enthusiastically, especially to requests to scrutinize the workings behind published results. It was such reluctance, in the face of a barrage of Freedom of Information requests, perceived by the scientists involved as mischievous, that led to the 'Climategate' affair. Accounts of this and the associated 'hockey stick controversy'[113, 114] can make uncomfortable reading for those with high expectations for standards of scientific conduct.

The internet also provides a platform and 'echo chamber' for voices offering a potent mix of science, pseudo-science, misinformation, opinion and name-calling, all free of quality control or rigorous review, and unconstrained by normal courtesies. We will return to this issue later, noting in passing that the nature and implications of the internet as a platform for discourse are as yet poorly understood – despite some early investigations[158].

Here we note that there are evidently many issues to address in 'opening up' the scientific process – not least the gulf between the knowledge and experience of experts and non-experts, and the time and effort required to deal with this. Nevertheless, there is growing evidence that there is much to be gained from the increased transparency made possible by public involvement[159] and from the increased division of investigative labour that such participation offers. The latter not only opens up the possibility of tapping into a vast resource of skills, viewpoints, experience and effort, but provides a means to develop the co-production approach to policy formulation discussed earlier.

3.8 Reluctant Cross-Disciplinarity

Climate science is a supremely complex subject. It addresses a 'wicked' issue, which is intricately entwined within a host of other environmental and societal problems. Its task is to explore and understand the workings of a vast and complex co-evolved system, and the nature of that system's response to a geologically rapid and significant human-induced shock. In doing so it transcends a multitude of traditional disciplines, ranging from atmospheric physics to psychology. Keeping up with the sheer flux of material in any one specialism is itself a challenge, but to arrive at climate science's conclusions requires the assembly of myriad elements of disciplinary knowledge into a unified and accurate synthesis. The dual tasks of carrying out and synthesizing the science represent an enormous and demanding cross-disciplinary challenge.

It is well known that cross-disciplinarity is hard to achieve. Even overcoming the barriers between closely related subjects can be problematical. John Ziman, in a deeply insightful essay[160], explored the underlying forces at play. He observed that specialization is a rational response to the norm of originality ("Caught between the totality of human knowledge and the immensity of human ignorance, what is one to do? The only practical policy is to specialize"). He conjectured that resistance to cross-disciplinarity has deep psychological and social roots, and has always been a dysfunctional feature of science, amplified by shortcomings of the academic rewards system. This is despite the evidence that "the most significant new ideas are usually combinations of old ones"[161].

Ziman observed: "The function of research management is to encourage and guide researchers to work voluntarily on desired problems". This includes assembling the cross-disciplinary teams necessary to address complex, high-priority issues. It was this imperative, namely the need to agree priorities and set up internationally coordinated projects to execute and synthesise climate science, that led to the establishment in 1980s and 1990s of the World Climate Research Programme (WCRP)[26], the International Geosphere-Biosphere Programme (IGBP)[27] and International Human Dimensions Programme (IHDP)[162]. Together these sought to encompass the Earth system as a whole. Figure 4, based on a schematic of climate-related Earth-system processes by Francis Bretherton[163], illustrates the relationship between the three programmes.

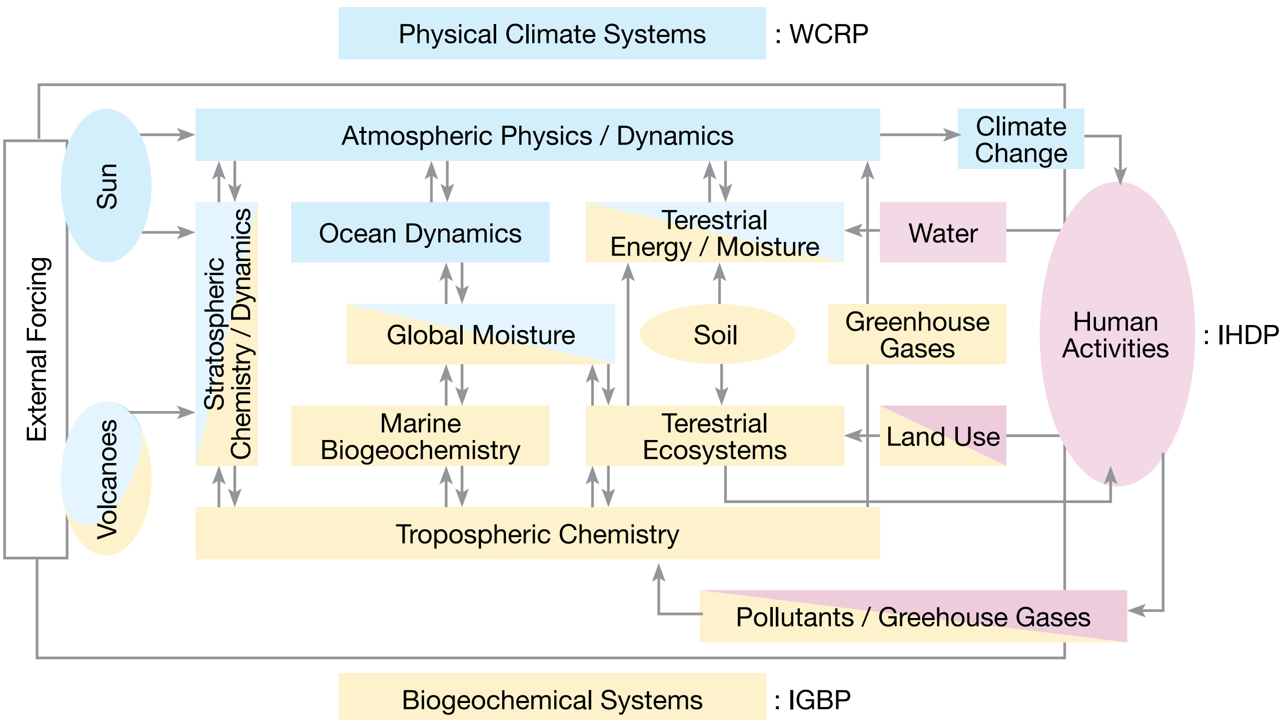

Figure 4: The relationship of the three original international Global Change research programmes illustrated using a modified version of Bretherton's schematic of climate-related Earth-system processes[164]

It was the same imperative that led to the establishment of a variety of real and virtual climate science institutes. Examples include the Potsdam Institute for Climate Change[165] in Germany and the Tyndall Centre in the UK[166.] Other initiatives with the same objective include the restructuring of research programmes at research institutes such as the British Antarctic Survey[167] and major international enterprises such as the International Polar Year 2007–2008[168].

The need to break down disciplinary barriers remains an ongoing issue, as exemplified by the UCL Grand Challenges programme, of which the UCL Policy Commission on Communicating Climate Science forms a part. A further example is the restructuring of the international Global Change programmes (IGBP, IHDP and DIVERSITAS[169]) into Future Earth[17].

3.9 The Perils of Over-Simplification

Albert Einstein observed that to tell a complex story it is necessary "to make everything as simple as possible, but not simpler"[170]. For reasons discussed in the previous section, the story of climate science is especially complex and challenging to express. The resulting temptation is to simplify. But to do so risks oversimplification and hence misunderstandings, misrepresentations and inconsistencies that, when revealed, threaten credibility and trust (and thus damage the 'brand').

As long ago as 1991, Bill Mitchell[18] expressed worries on this account. As a physicist, he was especially critical of the use of 'mean global surface temperature' as a state variable of the climate system, pointing out that it is thermodynamically meaningless and provides no useful insight in the perception or evaluation of climate risk. To understand the energy flows and fluid dynamics of the system, or the implications of climate change for humans, it is the spatial and temporal variations in temperature (and other parameters) around the world that matter. This fundamental shortcoming has been compounded by the incorporation of mean surface temperature into the 'climate sensitivity', defined as the change in the equilibrium value of the temperature in response to a doubling of the atmospheric concentration of carbon dioxide (CO_2). Climate sensitivity is widely used as a representative metric when discussing the future path and societal risks of global warming. It is not difficult to see that a substantial increase in the temperature of one half the planet offset by an equal and opposite decrease in the other half could have a major impact on the behaviour of the climate system, and on the wellbeing of humanity, whilst corresponding to a value of climate sensitivity equal to zero. The wisdom of the use of either of these parameters in the public discourse is thus deeply questionable. Yet it is a limit on change in the mean surface temperature that has been adopted as the very foundation upon which the international negotiations to mitigate climate change are being carried out under the auspices of the United Nations Framework Convention on Climate Change.

Other problematic oversimplifications abound. These include the framing of humanity's impact on the atmosphere in terms of temperature change (a secondary issue) rather than as a planetary energy imbalance (the primary consequence), and the adoption of phrases such as 'global warming' (which routinely conflicts with direct experience) and 'climate change' (which does not distinguish between natural and human causes), rather than 'climate disruption' (which captures the potential risk of our perturbing the climate system out of the unusually stable Holocene state during which civilization arose, and upon which the design of modern world infrastructures is based).

Evidently there is a need to rework the climate science narrative – to provide a clear, coherent and accurate statement of what is known, what is suspected and what is not known, that is both sufficiently simple and relevant to be relevant to a range of audiences, including non-experts, and is consistent with, and robust against, unfolding reality (of the climate system) and events (new discoveries, challenges, shortcomings of process or people).

3.10 Further Issues of Uncertainty and Risk

We have already discussed differences between lay and expert perceptions of uncertainty and risk (Section 2.8). Here we note that a central tenet of experimental science, drummed into every young researcher, is that a measurement has no value without an estimate of its uncertainty. So strong is the imperative that it constitutes a central cultural norm. As a result, when presenting their results, scientists feel compelled constantly to emphasise the associated uncertainties.

This has an unfortunate consequence, since in addition to the psychological issues already discussed, science is widely understood by the lay public to consist of a body of hard-edged laws and facts. This expectation contrasts with the perspective of science held by its practitioners, whose interest and motivation is to explore the realm of the unknown and to extend the limits of knowledge, where uncertainties abound. A consequence of the mismatch is that an unrelenting emphasis on uncertainty is interpreted by non-scientists as revealing confusion – or at least as indicating that less is known about a given scientific issue than is actually the case. The effect is to reduce faith in science ('Surely after all that effort and expenditure you could do better than that?'), to raise suspicions ('Why aren't you telling me what you really know?') or to justify the postponement of difficult decisions ('Let's wait until the science is settled').

A means of addressing these issues would be to adopt a 'risk' framing (once again noting issues raised in Section 2.8). Within business and organisational management the control of risk is routine and well understood. It forms the basis of prudent action: to increase resilience by lowering both the probability and impact of pertinent threats. A shift to a risk framing within climate science, whilst clearly acknowledging inherent and often irreducible uncertainties, would thus seem sensible.

Unfortunately, there are many examples of scientists reinforcing the *status quo*, not only through their reluctance to relax the norm, but by offering to 'reduce uncertainties', when in practice additional research often magnifies uncertainties by revealing greater complexity, and by failing to stress sufficiently that within complex entities such as the climate system some uncertainties are irreducible. The situation is exacerbated by often incomplete, distorted or partial reporting of uncertainty in the media.

James Painter's comprehensive review of the issue[171] provides a detailed analysis of the representation of uncertainty and risk in recent media coverage of climate change. We defer to Painter's helpful contribution, and will not delve into that aspect further here, other than to note his observation: "Many argue that when compared to the messages of disaster or uncertainty that often surround climate change, risk is far from being a panacea, but it does offer a more sophisticated and apposite language to have the discussion in, and a more helpful prism through which to analyse the challenge."

3.11 All Models are Wrong But Some Can Be Useful

A central feature of climate change science is a heavy emphasis on prediction. Dan Sarewitz[172] points out: "Scientists are attracted to the intellectual challenge of making predictions, and recognise that promising to provide predictions appeals to the interests of policy-makers who fund them." He continues: "And decision-makers would prefer to hand over responsibility for the future to scientists – who would also take the blame when wrong." (e.g. "We thought we were dealing with experts."[173])

Sarewitz challenges the assumption that ever-improved predictions are a critical ingredient of wise decision-making, noting that "if wise decisions depended on accurate predictions, then in most areas of human endeavour (they) would be impossible". He argues that earthquake science was fortunate because it was quickly evident that exact predictions were probably impossible. As a result, the focus of the interaction between science and policy has been to improve resilience, addressing building standards to minimise the risk of structures collapsing, and addressing emergency recovery plans in the event that they do.

In contrast, the origins of climate science from within the meteorological forecasting community have resulted in an implicit assumption that, with a larger computer, more funding and a bit more time, prescriptive advice – and effective action – will follow. Sarewitz cautions that this is a flawed assumption, and uses the case of Hurricane Katrina to illustrate the point. Despite very accurate prediction, decades in advance, of the likelihood of such an event – and, over the preceding days, of the specific threat – the fate of New Orleans was sealed by “a lethal combination of socioeconomic and racial inequity, regional environmental degradation, unwise development patterns and engineering failure”. It was the prior policies and the levees that failed, not the predictions.

He concludes by recommending that “science should focus more on understanding the present and less on predicting the future”, pointing out that with policymakers confronted by the dilemma of having to commit to major expenditure up front for uncertain benefits in the future, climate science could help “by moving away from its obsession with predicting the long-term [presumably 2050–2100] future of the climate, to focus instead on the many opportunities for reducing present vulnerabilities to a broad range of today’s – and tomorrow’s – climate impacts. Such a change in focus would promise benefits to society in the short term and thus help transform climate politics”. In a similar vein, others suggest the pursuit of multiple ‘no or low’ regret initiatives aimed at delivering benefits over a range of near-to-medium term timescales, recognizing that this would not only break action deadlocks, but would benefit from the influence that behaviour has on attitudes (Section 2.4).

More generally, prediction is a risky business, since every failure, real or perceived, calls into question the credibility of the source. The UK Meteorological Office, despite generally high levels of public respect and trust[174], has repeatedly suffered the consequences. Examples include pronounced criticism regarding the ‘Great Storm’ of 1987[175], the ‘Barbecue Summer’ of 2009[176] and the ‘Dry Winter’ of 2013/2014[177]. Pielke[24] points out that, based on our long experience of weather forecasting successes and failures, we have all unconsciously developed an heuristic that we use to discount daily meteorological predictions. It would take thousands of years to build up an equivalent level of experience to judge the skill of 100-year climate forecasts. Coupled with a tendency to confuse weather events with climate, and the difficulty of envisioning the situation globally (as opposed to locally or regionally), our natural ability to assess climate predictions is limited. Pielke identifies five criteria that determine when decision-makers can rely on predictions. He observes that long-term climate predictions (or projections) fail with respect to each, whether expressed as certain forecasts or probabilistic scenarios. This raises concern at the prominence of such predictions in the climate dialogue, and about their central role in policy formulation.

Some related points are worth making. Firstly, a computer model is merely a tool, and the caveats that accompany its products need to be clearly stated and considered judiciously. The point is explored in detail by Lenny Smith and Arthur Petersen, who distinguish three kinds of reliability (statistical, methodological and public) and emphasise the need to consider each in the context of a given purpose[178]. They recommend that it is not sufficient to add a 'health warning' to climate predictions or projections, but that it is necessary to work closely with decision-makers to ensure that strengths and limitations within a given context are properly understood (i.e. the Honest Broker/co-production model of Section 1). They note:

> "Failing to highlight the shortcomings of the current science will not only lead to poor decision-making, but is likely to generate a new generation of insightful climate sceptics, rightly sceptical of oversell, of any over-interpretation of statistical evidence and of any unjustified faith in the relevance of model-based probabilities".

Secondly, according to the rules of scientific logic, only unsuccessful predictions (disconfirmations) bear conclusive implications for scientific advance. This is ironic, since it is prediction failures that have been the target of scathing condemnation by climate change critics. Yet it is precisely those failures that reveal gaps in our understanding, and open up the possibility of new scientific advances.

Thirdly, it is important to challenge the misconception that the case advanced for human-induced climate change pivots on the output of computer predictions, when in reality it is based on a pattern of results drawn from fundamental theory and observations, assisted by modelling.

Fourthly, there is a distinction between modelling to inform mitigation, and modelling to inform adaptation. The former addresses timescales of order a century and beyond, where uncertainties about societal driving forces can be dominant. Furthermore, since the primary driving force of change (greenhouse gas emissions) is irreversible and the consequences delayed by multiple decades, there is a premium on predictive accuracy. In the case of adaptation, however, timescales are shorter, and responses can benefit from adaptive flexibility. This is well illustrated by the Thames Estuary 2100 plan drawn up by the UK Environment Agency to protect London from tidal flooding[179]. The 'decision pathways' approach adopted recognizes decisions will have to be made in the face of irreducible uncertainties about the detailed threat, even taking into account ongoing advances in predictive capability. To assure a given level of protection into the future whilst avoiding unnecessary expenditure, critical decision points are identified and options defined which allow subsequent flexibility should the predictions prove wrong[153, 154].

Finally (as discussed in earlier sections), there is a compelling argument that, whilst from a scientific standpoint there remains much to explore, for the purposes of policy 'we know enough' about the general trajectory of climate change and the requirement for a response. A continued emphasis on prediction diverts attention from the much more important, difficult and politically unattractive task of evaluating and deciding upon policy options.

3.12 Climate Science is Different

In this section we have explored a variety of issues that complicate the 'branding' of climate science. We finish by drawing attention to four additional aspects of climate science that cause its communication to be especially challenging.

It is complex. The conclusion that climate change is real, driven by human actions and problematical derives from a pattern of evidence, not from a single 'killer fact'. Describing the array of evidence takes time and effort, and is not conducive to a sound bite. In contrast, climate dismissive arguments can be seductively simple ('It's natural', 'It's the Sun', 'Humans have always adapted'). Bryant Welch, in his book *State of Confusion: Political Manipulation and the Assault on the American Mind*, points out that when humans are perplexed or overwhelmed, they are strongly motivated to seek simple, clear solutions voiced by a perceived authority[180].

Its conclusions are unwelcome. The implications of climate disruption generate strong emotional reactions. Some people are galvanized into action (supportive or dismissive – see Section 5.2), but for many the natural response is to avoid bad news either by negation (believing something untrue that is true) or defensive avoidance (unconsciously accepting that something is true, but finding ways systematically to refute or ignore it – for example, see Sally Weintrobe's book *Engaging with Climate Change – Psychoanalytic and Interdisciplinary Perspectives*[181] and the article by Ann Karpf[182]). Susanne Moser points out the numbing effect of climate science delivering a constant onslaught of bad news: "for most people it is challenging to keep listening to (such) depressing news. … The problem is too big, too complicated, too overwhelming – it's hopeless"[183].

Its conclusions are inconvenient. Climate science offers a stark message: that to avoid serious future risks, rapid transformative action is required to reconfigure the world's energy generation system, the economic system and global political practices. Machiavelli's insight applies: "There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things"[184].

It is contested. A brief visit to a climate-dismissive blog site, or to comments posted on a climate-related media article in the right-wing media, will reveal the depth of antagonism that exists towards climate scientists, and the rich seam of dismissive arguments in play. Lacking a mechanism to eliminate misunderstandings, flaws and errors, the same arguments tend to be constantly recycled, even when discredited. A natural reaction of scientists, unused to dealing with raw personal attacks, or with having repeatedly to deconstruct and expose the same flawed material, is to disengage, leaving the climate-dismissive ‘echo chamber’ to build up its own alternative ‘reality’.

3.13 Summary

We have identified a number of factors, some general and some specific, that place levels of public trust in climate science and climate scientists at risk. Regarding behaviours, we have identified issues of unrealistic expectations, misconceptions about the nature of science and the scientific process, shortcomings of the scientific process, a mismatch between the natural rhythms of science and those of the media and blogosphere, and a varied and uncertain reaction by scientists to the new realities of the internet and its transformative impact on the democratization of science and policy.

Regarding messaging, we have pointed out a tendency to make misleading oversimplifications, to emphasise uncertainty rather than risk, and to overemphasise the contribution of prediction. We have noted four aspects of climate science that make it especially challenging to communicate – that it is complex, unwelcome, inconvenient and contested. Arguably the most fundamental lack is that of a unified voice persistently delivering a ‘meta-narrative’ which is accurate, engaging, coherent and relevant, and which – by making clear the limits of certainty and knowledge – is robust against new discoveries and unfolding events. We will consider how these issues might be addressed in Chapter 6. First we explore the power of storytelling in engaging and informing an audience.

Horseman by Dame Elizabeth Frink. Photograph Joe Low

CAPTURING AN ENGAGED AUDIENCE

Chapter 4

KEY POINTS

- Narrative offers a powerful means to engage an audience and convey complex concepts.
- When dealing with non-experts in climate science, scientists should adjust their approach accordingly, avoiding undue reliance on the information deficit approach, and overcome their reluctance to employ the elements of successful narrative including personalizing their story, drawing on emotions and expressing their opinions.
- Despite long-standing tradition and pressures to the contrary, dialogue rather than debate offers the means to identify common purpose and foster constructive, evidence-based discourse.
- Climate scientists can gain much by working with and learning from those expert in public discourse, including the arts, museum sector and media.

4.1 Telling Tales: The Compelling Power of Narratives

Human beings are profoundly social. Unlike large groups of animals, which merely aggregate together, human groups are structured by hierarchies of age, gender, class and status that require constant monitoring. Given that the addition of even one extra group member results in a nonlinear increase in the number of two-way relationships within the group, it is unsurprising that humans should have developed mechanisms that allow them to negotiate their social world. Indeed, some commentators have argued that it was precisely this computational pressure that drove the evolution of the human brain itself, which, like the average human group size, is proportionately larger than in any other primate species.

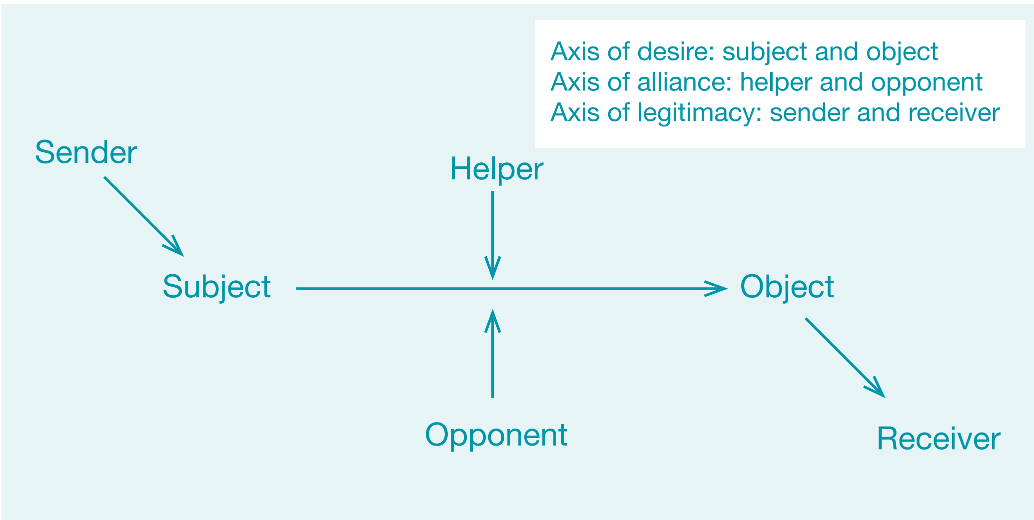

Figure 5a: Narrative Structure (after Greimas[185])

Narrative is by far the most versatile cultural tool for modelling social relations. Many different definitions of narrative are available, but where they generally concur is in announcing narrative as representation of how agents –real or fictional – interact in time. Though seemingly unexceptionable, this definition conceals a remarkable descriptive power on the part of narrative for characterising social life (see Figure 5a). In the first instance, narrative reflects the most common of all human experiences – that of lack. At its core, every narrative features an agent (a subject) who, consciously or unconsciously, desires something that they do not have (an object). To get this prized object, however, they must struggle – and this brings in the second important dimension of narrative. Though we are enmeshed in social relations of many types, they all, ultimately, reduce to relations that either help or hinder us. This is reflected in the struggles of the narrative's protagonist, who enters into alliances with helpers and enmities with opponents that make the goal easier or harder to achieve. Finally, there is the question of legitimacy. It is not enough for a protagonist to seize the object of their desire; they must be justified in doing so. Thus, even when the protagonist operates at a material disadvantage, most narratives will still afford them moral superiority vis-à-vis an opponent. This is generally achieved by having a conferring authority (a sender) that dispatches the protagonist for the benefit of some greater purpose (the receiver). Narrative therefore offers a thumbnail picture of how the three principles that govern social life – desire, alliance and legitimacy – enact themselves in time.

Significantly, however, the explanatory power of narrative is not restricted to our day-to-day interactions with other people. Because narratives work with deeply familiar categories and roles from the social world, they provide a convenient conceptual shorthand for reducing complex information or threatening unknowns to a more manageable form. Think, for instance, of the many mythologies that describe the creation of the world using the logic of agency, where gods, demi-gods and humans are attributed responsibility for natural phenomena. It is, in fact, only relatively recently in human history that scientific models of natural phenomena have begun to supersede narrative ones. Equally, narratives serve to simplify complex historical and political realities by collapsing a multitude of individual actions into that of a religion, ethnicity, nation or gender. In some cases, this is an empowering process that uncovers possibilities for collective action where none before existed. In other cases, narratively mediated thinking is an exercise in power that serves only to disqualify the moral or intellectual claims of out-group members – regardless of the evidence that may be presented in support of these claims.

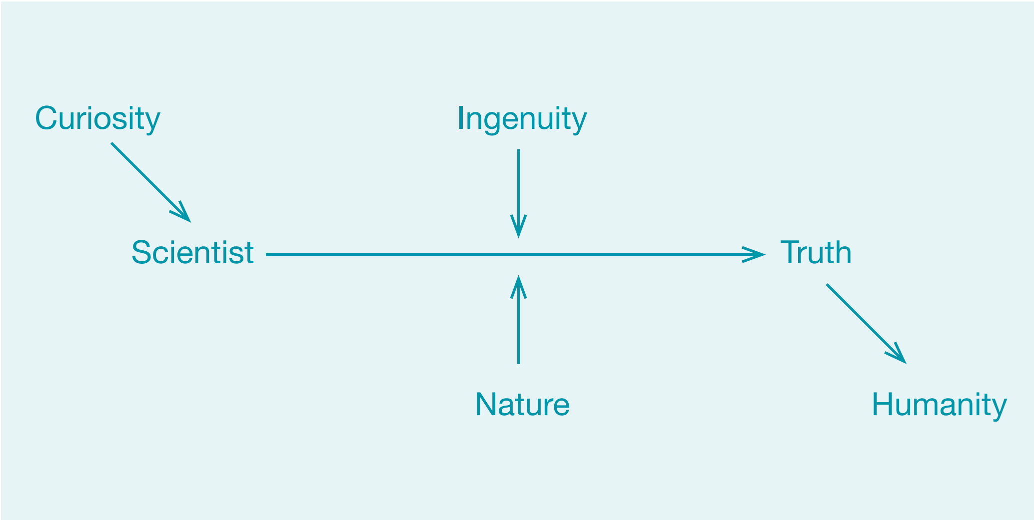

Figure 5b: Science as a quest for truth

Even when we are not explicitly engaged in narrative thinking, we often frame what we are doing in narrative terms. This can be seen in how the scientific enterprise is conceived of by its proponents. Specifically, though science itself is non-narrative in character, it is frequently presented in the form of a quest, where the scientist, aided by ingenuity and dispatched by curiosity, combatively wrestles with the complexities of nature (or alternatively with those who dismiss the validity of the science) with a view to retrieving (or defending) truth for the benefit of humanity (Figure 5b). The story can readily be inverted, presenting the scientist instead as the alarmist or dishonest hand of establishment thinking, with whom the enlightened and virtuous dismisser, energised by truth, must engage in rhetorical battle for the greater good (Figure 5c).

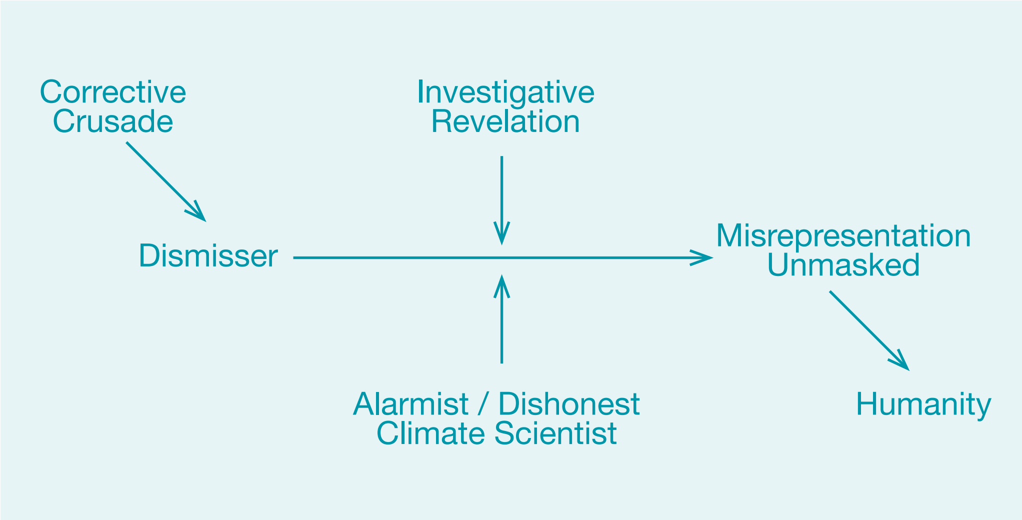

Figure 5c: Climate dismissal as a revelation of distortion and hoax

Ultimately, the point to retain is that narrative is a mode of thinking that originated in the demands of the social world. This makes it a superlatively useful tool for explaining as a unified and satisfying package of facts and motivations why people believe and act the way they do. However, it also means that narrative is less concerned with conveying objective truth than it is with pressing truth into the service of partisan social objectives. Certainly, this does not rule out narrative being harnessed to progressive social ends – but it does counsel us to remain prudently suspicious of its claims.

4.2 Science Communication Basics

So what role has narrative in the communication of climate science? We noted in Section 1.4 that in reporting their work to their peers, scientists traditionally adopt a standardized format ('objective–method–results–conclusions'). Specialized terminology is employed, including the language of mathematics, as are sophisticated styles of visual display and analysis. The material presented is predominantly factual. The objective is to maximize the transfer of information and minimise the time and effort taken to do so. A key condition for success is that the 'expert' audience is familiar with necessary contextual knowledge – usually extensive, technical and nuanced. Researchers are trained and practised in this style of delivery[186] and are judged by their peers on their proficiency at doing so. A consequence is that those same researchers, steeped in their specialist practice, can find it difficult to recast their presentations for a lay audience. Partial or complete communications failure follows as a result, since the audience is unfamiliar with the delivery format, and is ill-equipped to evaluate the technical detail.

When this occurs (assuming engagement is not entirely lost) audience attention tends to focus on three questions: 'Does this person know what they are talking about?', 'Are they trustworthy?' and 'Do they share my cultural values and beliefs?'[87]. Depending on the answer to each question, the opinion of the presenter – as far as it can be deduced – is likely to be accepted or rejected. In other words, the material delivered is used to evaluate the scientist, not the science.

However, scientists are deeply reluctant to express opinions or judgements, even when confronted with or challenged by the opinions of others. The imperative to stick to the facts is a deep cultural norm. This is despite the argument (Section 1.3) that, as especially well-informed citizens, they have a right – if not an obligation – to express an opinion or judgement (with appropriate caveats and making clear the distinction). Not doing so often results in public and official frustration at what is perceived as a bewildering and annoying reticence to speak out.

When confronted with a communication breakdown, scientists tend to adopt the information-deficit approach, and to deliver more facts (or the same facts more slowly), assuming that information drives understanding and acceptance. But we have seen that delivering more information can worsen conflict over decision-making (Section 1.1), and cannot reconcile opposed attitudes (Section 2.4). So although the 'deficit' approach can be useful in some circumstances (e.g. for clarifying a point, countering an error or misunderstanding, and for establishing credentials), it is well known by expert communicators to be ineffective in general. Adam Corner[187] likens scientific facts to the words in a dictionary, which on their own are not very interesting, but once assembled into a story or poem can capture the imagination.

Numerous guides offer advice on avoiding common communication pitfalls such as the use of specialized or ambiguous terminology, overly complex slides, or too much technical detail[188]. Some delve deeper[187, 189–192], and some specifically recommend the adoption of a narrative-based approach. For example, Caroline van den Brul[193] draws on her experience as a BBC Science producer and editor, and more recently as a communications trainer, to promote the importance of issues such as the needs and interests of the audience, the use of emotion, the use of 'lures', the need to set detail in context, the need to project a 'human' yet authoritative image, and the power of puzzles and plots to raise curiosity and achieve engagement.

The origins of such advice can be traced back to Aristotle[194] who fully understood the importance in rhetoric of ethos (how well the presenter persuades the audience he or she is qualified to speak), pathos (appeal to the audience's emotions – directly or via metaphor or simile) and logos (the use of logic). Working with members of the arts and museums communities, who are familiar with making such connections and with provoking new thinking, offers a potentially powerful way forward, in which the role of the scientist is to ensure that the scientific content is rigorous and robust. Examples include Cape Farewell[195], Tipping Point[196] and the London Science Museum's gallery; atmosphere: Exploring Climate Science[197], [198].

Important though these issues are, they are only part of the story. In Chapter 3 we identified a variety of challenges that threaten the public standing of climate scientists and climate science. To be effective, a narrative presentation designed for a lay audience needs to take all these considerations into account. The objective is to integrate actors, motivations, facts and conclusions into a construct that, conforming to the narrative structure described in Section 4.1, provides a story that 'fits together' to produce a deep feeling of 'rightness' and certainty. If this is not done explicitly (as we have seen in Section 2.1) it will be done anyway, consciously or unconsciously, as the mind seeks to draw 'meaning in context'. Better therefore to provide the intended interpretation explicitly.

We do not attempt to construct such a crafted narrative here, but instead provide an illustration of the power of well-judged storytelling, drawn from an account of a debate on climate change, in which a persuasive counter-narrative overwhelmed a carefully constructed exposition of the science. Ro Randall's blog describes a public debate on climate change[199]:

> "What stays in my mind is not the measured explanations of science, but (the opponent's) soup of random fact and populist story-telling. ... At one level, his speech was rubbish. He offered little argument. His facts were mostly wrong or irrelevant. He was incoherent on science and ignorant on policy. However, he offered an immediate emotional connection for his audience. He did this by presenting himself as the common man and the voice of common sense, appealing to stolid, British values such as plain-speaking, no-nonsense, down-to-earth honesty. He connected with some powerful emotions, such as people's fear of wasting money, and fear of 'having one put over on you' by people more powerful than you. He connected, through mockery, to a strand of anti-intellectualism and contempt for clever people who are deemed to create clever theories in lieu of seeing the plain truth in front of their eyes. … He was also a storyteller. His

speech was peppered with anecdote and visual imagery … that hooked the audience's imagination. Fundamentally, (he) connected to the desire in everyone that climate change should turn out not to be happening. … Who would not prefer that the bad news is wrong? He then built on this basic emotional connection by creating an enemy that can be blamed for frightening people (scientists and environmentalists) and provided a story about their motivations (personal profit and political gain) that could explain this."

4.3 Discourse not Debate

It is commonly assumed that contested societal issues can and should be resolved through debate. Examples abound, from school debating societies to the daily business of the British Parliament. But debates assume that there is only one right answer. They are combative in nature, and are about listening for flaws, defending assumptions and pursuing a predetermined outcome. They are about winning – and losing. Furthermore their outcomes are vulnerable to bias as a result of 'debate asymmetry' (Section 1.1) and 'false balance' (Section 3.4). By rehearsing their arguments, and through the impact on self-esteem of loss or gain, participants are driven further down their respective sides of the pyramid (Figure 3), and hence further apart in their convictions. Debate increases polarization. Yet the recognition that debate has unhelpful outcomes is not novel; it was the flawed nature of debate that motivated Socrates to propose dialectics as a preferred alternative.

The advantages of dialectic – or dialogue – are manifold. The starting assumption is that all participants have useful contributions to make. The approach is collaborative, is at least as much about listening as it is about speaking, and is aimed at finding common ground (and hence draws on the potential for reducing antagonism through working for a common purpose discussed in Section 2.5). It focuses on exploring assumptions, discovering new possibilities and seeking constructive progress. It offers a means of resolving issues ideal for the ‘co-production’ approach to science–policy interaction (Section 2.1).

Where it has been practised, it has been shown to work. For example, Ellen McCallie and her co-authors[200] describe the successful development of dialogue events at the London Science Museum’s Dana Centre with the goal of “creating circumstances such that … sustained dialogue between scientists and public participants occurs”. Experience of a longstanding programme of such events showed that the creation of such a ‘safe space’ allowed high levels of interaction and learning, and created circumstances under which people were able to keep an open mind, opinions could shift[201, 202].

We might ask, then, given its failings, why the debate format remains ubiquitous? First and foremost it may result from a determination on the part of either party to prevail over their opponents, with debate offering means to achieve this, and to be seen to do so. More pragmatic factors emerged from the Dana Centre experience; dialogue events are more complex and costly to deliver, requiring multiple breakout spaces, a greater number of ‘experts’, and more complex planning and orchestration. They are also difficult to scale up, with the need to achieve effective interaction between public and experts limiting participants to a maximum of 50–100.

But probably the most powerful – and insidious – reason is that a debate is a form of contest – and hence entertainment. As a result, it appeals to an audience who may or may not be interested in (or pay attention to) the content. It offers the vicarious pleasure of observing a battle in which fortunes ebb and flow as opponents fight for supremacy. For media seeking to attract viewers or to sell copy, a preference for the debate format is readily understood.

4.4 Summary

In this section we have explored the origins and social function of narrative and have seen that it provides a powerful means to communicate a package of facts and motivations in a unified manner that can ‘feel right’. We have noted that it is capable of conveying truth and untruth with equal force, and hence when employed in the service of science requires attendant care. We have noted that scientists, by and large, are unpractised in the use of narrative and that their communication with lay audiences could benefit from developing that skill. We have noted that in doing so, the construction and delivery of an effective climate science narrative needs to address a variety of factors, particularly that the subject matter is complex, unwelcome, inconvenient and contested. We have noted that in public discourse debate is combative and increases polarization. In contrast the use of dialogue is collaborative and seeks a constructive way forward, even in the light of irresolvable differences. We observe that dialogue provides a mode of discourse consonant with the role of the ‘Honest Broker’ and the co-production approach to science-policy interaction, which is more likely to enable progress in addressing the complex issues posed by climate change (Sections 1.2–1.3).

Photograph Joe Low

HOW CLIMATE CHANGE FEATURES IN THE PUBLIC CONSCIOUSNESS

Chapter 5

KEY POINTS

- There is widespread public acceptance of the reality of climate change, but not of the urgency and scale of the challenges it presents. This is at odds with the conclusions of climate science.
- The discrepancy derives from psychological factors and from clashes with deeply rooted values and political divisions.
- There is a need to reframe the debate on climate change and climate science in a constructive way that enables progress beyond entrenched positions, which engages both policymakers and the lay public in discourse about the scientific evidence and the appropriate policy responses.

5.1 Opinion Polls: What They Show

Results from opinion polls need to be interpreted with caution, since the information upon which they are based can deviate widely from people's unconscious thoughts and real behaviours. Nevertheless, polling data consistently indicate that public awareness of climate change is relatively high (over 80%). Polls sponsored in the UK by the Department of Environment, Food and Rural Affairs (DEFRA), and other research surveys conducted using nationally representative samples, regularly find that majorities say they know 'a lot', a 'fair amount' or 'a little' about climate change[203–207]. Majorities also agree that human actions are a significant driver of contemporary climate change, and express worry, to some degree, about its impacts[207–211]. Comparative polls conducted in the USA reveal similar findings[212–218]. Roger Pielke Jr[24] points out that these results are remarkable, revealing a level of public consensus far in excess of other issues on which political action is routinely taken. However, whilst these publics broadly accept that climate change is occurring, and that human activity plays at least some role in this, research has identified that the publics in the West are likely to regard climate change as temporally and spatially distant, and more serious for other people and in other places[219–224].

Despite consistent high awareness, levels of concern have fluctuated over recent years. Data from within the UK and USA, for example, demonstrate that between 2007 and 2010 the number of individuals worried about the issue fell[209], [212], [225–227]. Subsequent evidence is inconclusive, with some polls indicating that attitudes may have stabilized[207, 214], others indicating that the trend may have reversed[215], [216]. The percentage of the British public who are 'not very' or 'not at all' concerned about climate change apparently increased from 27% in 2010 to 35% in 2013[228]."

Numerous theories have been put forward concerning the drivers of public concern. Robert Brulle et al investigated five factors: extreme weather events, public access to accurate science information, media coverage, elite cues and competing advocacy[229]. They found that information and extreme events had little effect. Media coverage did exert an important influence, but this coverage was itself influenced by elite cues and economic factors. They concluded that political mobilization by elites and advocacy groups was critical. Nick Pidgeon, evaluating similar data, identified possible drivers as ‘issue fatigue’, the impact of the global financial crisis, and the deepening politicisation of the issue[229, 230]. Other possible factors include loss of trust, and the impact of ‘false balance’ in the media (Section 3.4). Potentially important, but as yet uncertain, is the impact of an increasing number of public attacks on climate scientists and their institutions via newspaper articles[4, 5], blogs[231], publications from right-wing think-tanks[232] and books[151, 233–235]. Allegations range from scientific dishonesty to political motivation and participation in a global conspiracy to perpetrate a self-interested hoax[147, 151, 234].

5.2 Factors Influencing Public Engagement

There is a growing literature examining the factors that influence how and why publics engage (or disengage) with climate change. Affective imagery – taken here to be feeling states associated with a particular word or idea[236] – has been found to play a role in whether or not individuals perceive climate change as a risk issue, and the degree to which they support or oppose policy measures designed to mitigate the threat[98, 100, 219, 237].

Engagement with climate change also shows a correlation with political beliefs and world-view, with research finding that support or opposition to climate policy is strongly associated with voting preferences. In the American context, people who identify themselves as Democrats are more likely to perceive climate change as a risk and support climate change policies than those who identify themselves as Republican[217, 238]. Polls show an increasing degree of divergence of Democratic–Republican views about climate change. An anti-climate-change stance is also prominent within the ‘New Right’ in Canada, Australia, New Zealand and, increasingly, the UK, where those committed to small government, free markets and individual initiative actively seek to associate climate change with other iconic right-wing 'bêtes noir'. For example, writers such as James Delingpole, in his book *Watermelons: The Green Movement's True Colours*[147], characterize environmentalists as "green on the outside, red on the inside", consistent with the view that environmentalism is perceived by the right as replacing communism as the 'enemy' following the fall of the Soviet Union. These partisan differences point to the underlying importance of cultural world-views, including egalitarianism and individualism, as more fundamental drivers of public reaction[87, 239] (see Section 2.6). The tension between such deep ideological differences is a key driver of human affairs, underscoring the need to disentangle climate science from such issues, which by their nature are ongoing and highly intractable.

5.3 Multiple Publics

There exists no single 'public' when considering climate attitudes and beliefs. Edward Maibach et al[240] used a segmentation model to explore US public engagement with climate change. From a nationally representative survey of approximately 2,000 American adults, six segments were identified covering a spectrum of concern ranging from 'alarmed', 'concerned' and 'cautious', to 'disengaged', 'doubtful' and 'dismissive'. Each segment had a unique perspective on climate change with respect to policy preferences, and issue engagement' after 'behaviours' beliefs and self-reported behaviours. The approach has been replicated in numerous subsequent surveys both within the USA and more internationally[241–245]. Numbers and segments vary from nation to nation and over time, but the spectrum and distribution of opinion in each show broad agreement.

Here we suggest that, from the point of view of communication, the segmentation can be considered in terms of three simplified functional subsets. The first – the 'Acceptors' – constitute those members of the 'alarmed' and 'concerned' (including 'alarmists') who seek to persuade policymakers and the lay public that human-induced climate change is real and merits a response. The second subset is the 'Dismissers', consisting of the ‘doubtful’ and the ‘dismissive’ (including ‘dogmatists’) who seek to persuade the opposite). The third group constitute the ‘Middle Ground’, who are disinterested, disengaged or unpersuaded (Figure 6a).

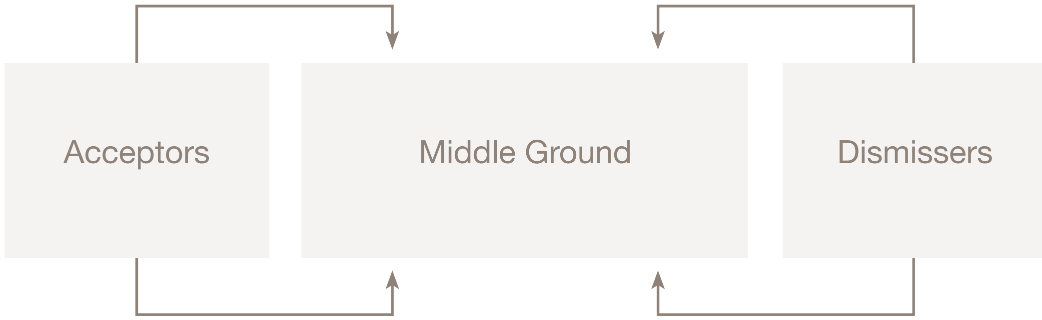

Figure 6a: Illustrating the struggle for influence over climate change

A common misconception is that the climate scientists form a substantial component of the Acceptor group operating in an ‘Issue Advocacy’ role; in practice, as pointed out in Section 1.3, there is a general reluctance on their part to do so, with only a relatively small subset operating in this way. That is not to say that ‘stealth advocacy’ does not occur. And it is certainly the case that senior climate scientists have a substantial influence over decision-making and policy, albeit in mainly in the ‘technocratic’ mode (Section 1.5). But the key point of Figure 6a is that it is represents the situation as a struggle between opposing forces – an instantly recognizable but unhelpful narrative. Given our conclusions about the need to disentangle climate science from ideology and politics, the advantages of dialogue over debate, and the benefits of decision-making through co-production (Section 1.2), this is highly undesirable.

Our conclusion then, is that for the good of society in addressing the issue of climate change, a prime objective should be to reframe the engagement, so that combative situation illustrated in Figure 6a is replaced by a co-production forum in which all interested parties are represented, in which the climate science community is embedded within a grouping of independent expert participants separate from the advocacy groups, in which the media and internet provide a connection to society as a whole, and in which the driving principle is to seek 'common purpose' and evidence-based, pluralist decision-making seeking to optimize societal benefit (Figure 6b).

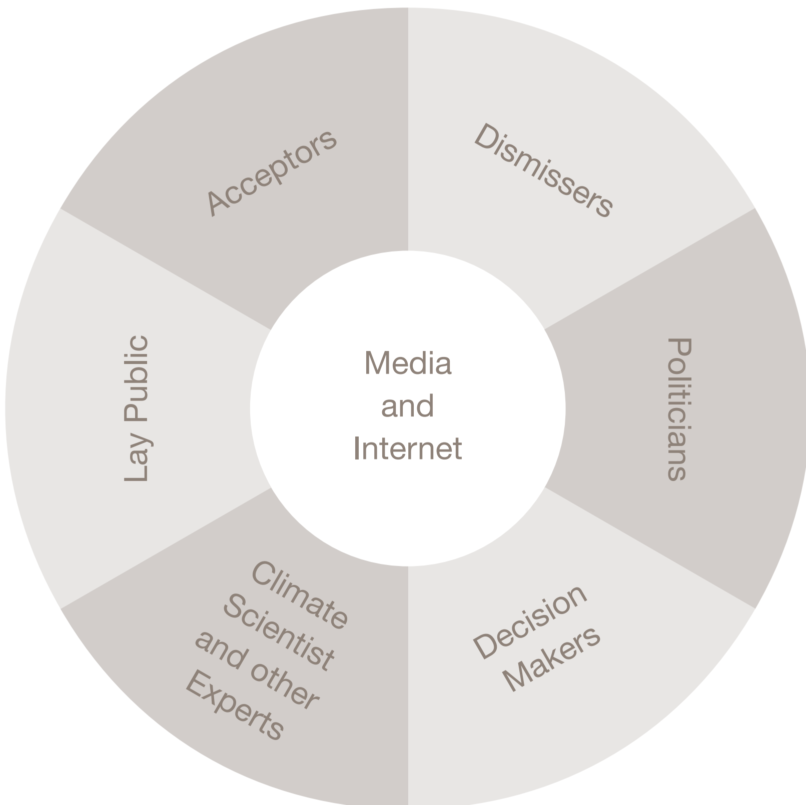

Figure 6b: The 'co-production' approach to the climate change discourse

5.4 Summary

In this Section we have noted that (in the UK and USA at least) polls indicate high levels of public awareness of climate change, and a relatively high degree of acceptance that human actions are its cause. We have seen that differences of opinion on climate change are rooted in differences of values, world-view and political ideology. We have seen that subsets of society committed to action – both those for and against a response – seek to influence power brokers and the lay public. We have suggested that for constructive progress to be made, it is imperative to find ways to defuse this partisan battle, and that the co-production approach offers a means to achieve this.

Photograph Joe Low

RISING TO THE CHALLENGE

Chapter 6

KEY POINTS

- Although numerous climate scientists are active in public engagement and policy formulation, they are the exception. For the majority the primary focus remains their 'Pure Scientist' role. The academic training systems and rewards structures provide limited capability or incentives for this to change.
- No mechanism currently exists to reconsider and reform the cultural norms and practices of climate science.
- The establishment of an operational body to fulfil the role of 'Science Communicator' could enable new types and levels of discourse between climate scientists, decision-makers, policymakers and the lay public.
- The establishment of a professional body for climate science, to represent the interests of climate scientists and society, would provide the means to develop norms, values and practices better tuned to the circumstances in which climate science finds itself.

6.1 What Would It Be Like?

We began this commentary with Jane Lubchenco's 1997 appeal to the environmental science community to "participate vigorously in exploring the relationship between science and society and in considering a New Social Contract for Science as we enter the Century of the Environment". Lubchenco recognised that in a world increasingly dominated by humans, environmental issues merited serious public and political consideration, and that as a consequence, scientists needed to rethink their role and objectives, and hence their behaviours. It was a call to establish a new ethos of cultural norms, values and practices.

In the intervening years numerous developments have served to intensify the imperative. These include changes within human interconnectivity through globalization and the growth of the internet, advances in the understanding of the human mind, and the development of the partisan political divide over climate science. Yet in practice, notwithstanding the efforts of many individual scientists to engage with the public and with policy formulation, and despite ongoing initiatives to foster cross-disciplinarity (Section 3.8), changes in the collective working practices of climate science have been modest. The 'vigorous exploration' has not taken place and the New Social Contract has not been forged.

What if it had, and what if climate science had transformed itself as a result? What would it look like?

Firstly, there would be a clear understanding about the climate science community's purpose. This would encompass the five roles discussed in Chapter 1, acknowledging a collective obligation to expand and deepen understanding of the climate system, to engage with society about it in a relevant and meaningful way, to answer factual ('positive') enquiries, and to participate actively in related societal decision-making.

Secondly, there would be a clear understanding about the community's objectives: to provide expert support to society, to identify better or more acceptable options, to inform multiple 'no or low regrets' practical actions as a pathway to the longer-term, and to emphasise the need to accommodate irreducible uncertainties, whilst being vigilant to avoid advocacy either directly or by stealth.

Thirdly, the mode of engagement with society would have been transformed and refined. This would have been achieved via a structured (science-based) approach to implement the 'Science Communicator' role and to encourage the co-production model of science–policy interactions, with the objective of ensuring their effectiveness, as well as their internalization as professional norms.

Fourthly, recognizing the importance of the science analogue of 'brand DNA' in developing and sustaining a positive public standing, the community would have established and made clear new behavioural standards and new consistency of narrative in a manner to maximize positive 'affect'. In so doing, they would have addressed the variety of issues raised in this report, including the need to:

- recognize the realities of the science–policy interface and take steps to separate the ongoing and essential fundamental ('pure') study of the climate system, from activities designed to support decision-making and the policy discourse
- recognize and acknowledge the inherent limitations of the human mind ('We are all less consciously rational than we think'), and the consequent inability of individual scientists to achieve their behavioural aspirations, as well as the origins of dismissal and antagonism within a subset of the audience
- strengthen the reality and public perception of the validity and effectiveness of the scientific process at revealing objective reality and its value in informing policy and decision-making
- welcome and actively expand the democratization of science via the internet and other means
- avoid, to the extent possible, the array of pitfalls identified regarding the content of climate science messaging (e.g. lack of consistency,

oversimplification, emphasis on uncertainty rather than risk, over-emphasis on the value of predictions)

- become storytellers – making judicious use of metaphor and verbal imagery – to engage constructively and interest society in the results and implications of climate science
- personalize the science, and, where appropriate and with necessary caveats, express opinions and judgements.

Fifthly, in an attempt to reduce the polarized and unhelpful nature of the public discourse, discussion would take place through dialogue rather than debate, 'safe spaces' for co-production would have been established with the aim of setting aside differences and identifying common purpose, with an emphasis on 'bigger than self' issues, that transcend ideologies and political affiliations. Key ingredients of the discussion would be a better understanding of, and positive engagement with, different concepts of uncertainty and risk, and an admission on the part of all parties that 'I might be wrong', coupled with active critical reflection, and the channelling of the dissonance generated into positive thinking and action.

6.2 Mind the Gap

So what could be done to close the gap between this vision and the present-day reality? To address this it is first helpful to consider why the transformation has not taken place.

At its root, Lubchenco's New Social Contract requires a substantial reform of climate scientists' roles and behaviours. Susan Michie and her co-authors[246] have developed a generalized framework to analyze, characterize and address behavioural change challenges. The Behavioural Change Wheel identifies three factors that are necessary and sufficient prerequisites for the performance of a specified volitional behaviour. These are motivation (the brain processes that energise and direct behaviour), capability (these may be physical or psychological, the latter being the knowledge and skills necessary for the behaviour) and opportunity (the physical and social context that enables or promotes the behaviour). Motivations may be 'reflective', in the sense that they involve analyzing the cost and benefits of a given course of action (e.g. belief that an activity is 'wrong' or 'harmful'), or 'automatic', in the sense that they involve drives, emotional processing and habits. Any given behaviour in its context can be analyzed within this framework, revealing the location and nature of the issues that are blocking progress and the alterations that are required for the behaviour to change.

In the case of transforming the norms, values and practices of climate science, motivation presents a significant obstacle. We have noted that the prime motivational driver for most researchers is carrying out their science (Section 1.3). As the climate science enterprise has expanded, ever-larger numbers of researchers have found themselves "privileged to be able to indulge their passion". As a result, there has been little incentive for already busy individuals to take on additional demanding commitments in areas of climate science communication the science–policy interface for which they have little training or experience. Factors reinforcing the situation are the academic rewards system, which continues to place priority on publishing original research, and a pervasive prejudice amongst scientists that 'outreach' activities are lower status than, and a distraction from, the main objective (i.e. understanding and predicting the climate system)[40].

Those individuals who have engaged in such activities, with notable exceptions, have tended to be drawn from the more established members of the community. These figures are arguably better able to take the time and the risk (as well as being seen as more 'expert'), having more freedom of control over their schedules and being more secure in their posts. Although they have been rewarded through increased status, influence and access to power, many have found the consequences double-edged, having become the target of attack within the blogosphere and the media. At the institutional level, the experience has been similar.

Even assuming it were possible to generate a 'strong intention', a second issue blocking progress concerns capability. Typically, once objectives have been agreed the execution of transformational change requires a combination of know-how, and strong leadership. We have noted the general lack of familiarity of climate scientists with the insights of the political and behavioural sciences (representing highly relevant know-how), and this is undoubtedly an obstacle.

More fundamentally, the science community is 'self-organising' and not amenable to authoritative direction (see also Section 1.4). This is a cherished principle, enshrined within the UK by the Haldane Principle[247], which ensures that the focus of research is under the control of scientists, free from political and administrative pressures. Similar arrangements apply in most nations worldwide. The unwitting consequence is the lack of an instrument or means by which collective reform can be addressed. In addition to protecting science against political manipulation, the situation is analogous to that of the free market in which it is assumed that the 'invisible hand', corresponding to the aggregate consequences of countless individual decisions, drives progress more effectively than centralized control. As is the case for the financial markets, the scientific enterprise is vulnerable to its insensitivity to externalities that by definition have no influence on individual decisions. In the case of climate science, the need to better serve society is one such externality. The need to overcome cross-disciplinary barriers is arguably another.

For free markets, the curative mechanism is regulation. But this is only possible through the intervention of a higher authority, typically government regulation through law. As we have seen, the science enterprise has been established in a manner designed specifically to prohibit such intervention. The challenge then is to find a means by which change can be effected voluntarily, retaining the integrity of the Haldane Principle, yet achieving the psychological capability (engaging in the necessary thought processes of comprehension and reasoning) and the physical capability (developing an instrument and mechanisms) to make progress. To foster cross-disciplinarity (and international coordination) the solution adopted was to establish the Global Change programmes that derive their legitimacy from their sponsorship by the international science bodies (World Meteorological Organization, International Council of Science, International Social Science Council). We build on this approach in the next Section.

Regarding opportunity, the situation is mixed. Concerning communication, despite a view within some parts of the media that climate science is 'toxic' and hence a risky subject in which to invest effort, there is evidence that the lay public are interested to learn more in order to be able to 'make up their own minds'. This is illustrated by the popularity of public lectures, articles and books on the subject, and, for example, by the experience of the 'atmosphere' gallery at London's Science Museum[197] (two million visitors in just over two years), and by the success of the museum's Dana Centre dialogue events.

Concerning the science–policy interface we have noted the inappropriateness of the 'technocratic model', the danger of the 'Iron Triangle' (Section 1.5), and the need to shift responsibility and accountability for society's decisions on the results of climate science back to the democratically-elected politicians and decision-makers. Although examples of scientist involvement in co-production-like activities exist (see Section 1.5), and although references to its desirability can be found, these are the exception rather than the rule. For example the Research Councils UK *Strategic Vision*[248] and *Pathways to Impact*[249] betray their origins in the 'technocratic' mindset and are far from conforming to the concept outlined by Mike Hulme (Section

1.2) and illustrated in Figure 6b. In practice this may prove the most difficult obstacle to overcome, since it confronts the difficulty of changing established practices in policy formulation and decision-making that lie outside the influence of climate scientists.

6.3 What Next?

We have seen that the ethos and practices of the climate science community, forged in the immediate post-Second World War era, require reform to meet the needs of modern society better. In Section 6.1 we identified areas in which current practices require attention, and in Section 6.2 we identified obstacles to progress. These represent a substantial challenge. But, given the lessons of branding (Section 3.2) and the insights from our broader explorations, we reduce the complexity to six fundamental needs, that if resolved would represent a major advance:

1. The establishment of a forum for an active and authoritative public conversation about the results and implications of climate science.
2. The ability of climate scientists to identify themselves and demonstrate professional credentials.
3. The means to represent climate science with authority in its dealings with society (decision-makers, politicians and the lay public) and to engage with all relevant parties in a cooperative, co-production approach, seeking common purpose and the common good.
4. The means to promote high standards of education and training, and in particular to prepare climate scientists for each of the five idealized roles they may choose or be required to fulfil at different times.
5. The means to define and ensure professional standards of work and behaviour, including a commitment on the part of accredited scientists to aspire to these.
6. The establishment of a means by which all of the above can be discussed, agreed and worked towards.

We also note the conclusions of the recent House of Commons Science and Technology Select Committee report on Communicating Climate Science which demonstrate considerable parallels with the outcomes of this Commission:

> "A lack of clear, consistent messages on the science has a detrimental impact on the public's trust in climate science. The Government and other bodies, such as the Royal Society and the Met Office, are currently failing to make effective use of [the] internet or social media to engage with the public and to become an authoritative source of accurate scientific information about climate change. The Government must work with the learned societies, national academies and other experts to develop a source of information on climate science that is discrete from policy delivery, comprehensible to the general public, and responsive to both current developments and uncertainties in the science. The Government's current approach to communicating conflates the scientific basis of climate change and the proposed solutions to its impacts, and places a heavy reliance on individual scientists communicating about the science to justify the policy response. Efforts to create a clear narrative that is coherent, constructive and results in proper public engagement have been disappointing. As a matter of urgency, the Government needs to draw up a climate change communication strategy and implement this consistently across all departments."

Addressing the lack of an effective Science Communicator, we suggest the establishment of an operational body with two-fold purpose:

- to deliver persistently a 'meta-narrative' which is accurate, engaging, coherent and relevant, and which – by making clear the limits of certainty and knowledge – is robust against new discoveries and unfolding events
- to support public discourse on the results and implications of climate science, thereby building engagement, understanding and trust. Whilst various attempts have been made to fulfil the former role – ranging, for example, from the climate-supportive websites such as Skeptical

Science[44] and RealClimate[45], through to the Climate Outreach and Information Network (COIN)[250] and the Carbon Brief[251] – none has achieved the necessary combination of authority, operational capability, trust and active public engagement.

The additional needs listed above correspond to the functions performed by professional associations. Such bodies seek to further the interests of a given profession, the interests of individuals engaged in the profession, and the public interest. Within the UK they are generally non-profit bodies established by Royal Charter or under British law. In the case of climate science, given its international nature, a free-standing professional body could be established voluntarily by the community, exploiting the internet. An alternative, which would carry greater legitimacy, would be to develop such a body under the auspices of a respected international science organisation, such as the Inter-Academy Panel[252].

Whichever approach were to be adopted, our view is that such a body – possibly called the 'International Union of Climate Science' – should be formed as a matter of priority. Its purpose would be to establish a new norms, values and practices for climate science, better attuned to the world in which climate science now finds itself. To do so would provide the practical means to facilitate Lubchenco's call, and thereby to develop climate science and climate scientists fit to satisfy the needs of society in the "Century of the Environment".

6.4 Conclusions

In summary we draw the following conclusions:

1. Climate scientists are finding themselves ill-prepared to engage with the often emotionally, politically and ideologically charged public discourse on the evaluation and use of their science. This is proving unhelpful to evidence-based policy formulation, and is damaging their public standing. As a result, there is a pressing need to re-examine and clarify the roles of climate scientists in policy, decision-making and public engagement. Their professional norms, values and practices need to be reconsidered and revised accordingly. In expanding their skills and expertise to better match societal needs, climate scientists can benefit from a mutually supportive working relationship with social and behavioural scientists, and with experts in public engagement and communication. Such reforms alone will not be sufficient to achieve a more constructive and effective formulation of policy and an improved public discourse, but they provide a crucial step toward those objectives.

2. A climate science 'meta-narrative' is required that delivers the results of climate science in a manner that is accurate, engaging, coherent, relevant, and which – by making clear the limits of certainty and knowledge – is robust against new discoveries and unfolding events. Multiple narrative threads, that are consistent and harmonious with each other, are necessary both to reflect the complex nature of the climate science, and to connect with audiences with different states of knowledge, interests, values and needs.

3. Policy issues raised by climate science are complicated by many factors (e.g. decisions on energy, food and water supplies, quality of life, equity, affordability, security, sustainability, societal resilience). Whilst climate science can inform such policy deliberations, it cannot be their arbiter. Decision-making should not be through the linear mode, characterised as 'truth speaks to power', but should be by means of collective 'co-production'.

4. Efforts to understand the climate system better are important, but they should not be allowed to divert attention and effort from decision-making and policy formulation based on what is already known. Reducing uncertainties in some areas may not be possible. Irreducible uncertainties can be addressed using a ‘decision pathways’ approach.
5. At its root, the public discussion of climate science is as much about what sort of world we wish to live in, and hence about ethics and values, as it is about immediate and longer-term material risks to human wellbeing. This needs to be clearly acknowledged and addressed. Establishing a positive and active public discourse requires recognition that people have feelings, anxieties, inner conflicts and world-views that can make it difficult for them to take information in, but that they are able to rise to a challenge if they conclude that there is a need.
6. New organisational instruments are required to support the public discourse on climate science and to achieve necessary professional reforms – notably a forum for active public discussion and a professional body for climate scientists.

6.5 Recommendations

Climate scientists have crucial roles to play in the public discourse on climate science and in working with others to determine the most appropriate societal responses. But, as described in this report, there is a need for the climate science community to re-evaluate its role and enhance its capabilities. To this end we make five recommendations addressing:

- Communication – developing a coherent and publicly engaged narrative
- Training – gaining additional skills beyond scientific practice
- Policy engagement – pursuing ‘co-production’ of policy decisions
- Leadership – establishing a professional body for climate scientists
- Self-reflection – seeking a better awareness and control of unconscious motivations

Communication: There is a need for an operational means of public engagement with climate scientists to deliver a coherent ‘meta-narrative’ of climate science that conveys the big picture and provides the context for discussion of the results, their uncertainties and their implications. The authentic and personalised voice of climate scientists in the formation and delivery of this ‘meta-narrative’ will be crucial. It will require the climate science community to develop and discuss the narrative in a way that seeks to increase the transparency of the scientific process and to strengthen public participation within it. The effective communication of this ‘meta-narrative’ will rely on successful use of and engagement with the media and the internet.

Training: There is a need to enhance the training and development of climate scientists. Specifically the objective is to equip the community with the skills to fulfill the roles of ‘pure scientist’, ‘science communicator’, ‘science arbiter’, ‘issue advocate’ and ‘honest broker of policy alternatives’. This will require effective action on the part of funders and universities to support and deliver the necessary training. The broader aim is to strengthen the functioning, transparency and public participation of the climate science process and with the degree of public participation within it.

Policy engagement: Climate scientists should participate actively in the 'co-production' of policy formulation and the decision-making process. This entails contributing their expertise alongside other experts and stakeholders to inform the deliberations of those with the authority, responsibility and accountability to make decisions. Progress will require a willingness and openness on the part of Government and other policy stakeholders, as well as climate scientists, to commit to such a approach.

Leadership: A professional body for climate scientists should be established to provide a unifying purpose and to offer leadership. Its roles should be as follows:

- **Representation:** It should seek to represent the interests of scientists and of society.
- **Voice:** It should provide the means for climate scientists to develop and communicate the climate science 'meta-narrative' and to work with experts in wider aspects of public engagement and communication to support this.
- **Standards:** It should define professional norms, values and practices appropriate to societal needs and provide guidance and input to improve the training and development of climate scientists.
- **Outcome:** It should support climate scientists in engaging in 'co-production' of policy by clearly defining the associated roles and expectations, and by providing a clear route for engagement between the climate science community and policymakers.

To these ends the body should facilitate a mutually supportive working relationship between climate scientists, social and behavioural scientists, and key stakeholders, with the aim of applying relevant insights to the practice of climate science).

Self reflection: Active critical self-reflection and humility should become the evident and habitual cultural norm on the part of all participants in the climate discourse. We need to be vigilant in scrutinising how we evaluate evidence and judge others. We are all less rational and more rationalizing than we think.

GLOSSARY

Abortion Politics – circumstances in which deeply held and opposed views rooted in ideology, religion, morals or ethics can be informed but not resolved by science; compare Tornado Politics, below. See page 26.

Co-Production Model – in which the goals of policy and the means of achieving them emerge from an inclusive and iterative process, comprising both scientific and non-scientific considerations. See page 29.

Debate Assymetry – in which the rules of rational discourse have been abandoned by some protagonists, typically to the disadvantage of scientists. See page 27.

Honest Broker of Policy Alternatives – engages in decision-making, contributing knowledge and understanding alongside a range of other participants to expand and clarify the scope of choice available, and to converge collectively on an agreed way forward; one of Pielke's idealized roles for scientists. See page 31.

Issue Advocate – engages with a decision-maker seeking to reduce the scope of choice available by promoting a particular course of action that they justify using their expert knowledge and understanding; one of Pielke's idealized roles for scientists. See page 31.

Linear Model between science and policy – characterised as 'truth speaks to power, and power responds'; also called the *Technocratic Model*. See page 26.

Myside Bias – the propensity to only see one's own side of an argument. See page 44.

Post-Normal Science – when either or both of 'systems uncertainties' or 'decision stakes' are high, under which circumstances traditional methodologies are ineffective. See page 31.

Pure Scientist – focused solely on generating 'facts' and delivering them to the 'pool of human knowledge', with no consideration for their use or utility, and no direct connection with decision-makers; one of Pielke's idealized roles for scientists. See page 31.

Science Arbiter – seeks to stay removed from explicit considerations of policy and politics but answers factual questions posed by a decision-maker; one of Pielke's idealized roles for scientists. See page 31.

Science Communicator – engaged with society to make aware and discuss the results and implications of the research that it has funded, including the task of raising the alert if the implications of a piece of research point to a significant societal threat or opportunity; a proposed addition to Pielke's idealized roles for scientists. See page 35.

Stealth Issue Advocacy – when a researcher either knowingly or unwittingly advances a political outcome when apparently focusing solely on science. See page 32.

Technocratic Model – See *Linear Model*, above.

Tornado Politics – circumstances in which there is a broad consensus on interests, values and beliefs; compare Abortion Politics, above. See page 26.

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All views expressed in the report are those of the authors alone.

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ASSOCIATED DOCUMENTS

Psychosocial Contributions to Climate Sciences Communications Research and Practice, Renee Lertzman (review commissioned by the UCL Policy Commission on Communicating Climate Science)

Seeing Yourself See (Report on the UCL Policy Commission on Communicating Climate Science event held in July 2013)

These and additional documents and commentaries are available at the UCL Policy Commission on Communicating Climate Science website.

UCL POLICY COMMISSIONS

UCL Policy Commissions are an initiative under the UCL Public Policy Strategy. They are a way of bringing together academics and researchers across disciplines to consider issues of considerable public policy importance and to attempt to address these by consolidating and synthesising knowledge and expertise. They aim to deliver novel insights derived from cross- disciplinary collaboration and to make policy recommendations on the basis of these.

UCL Policy Commission on the Communication of Climate Science

The UCL Policy Commission on the Communication of Climate Science was chaired by Professor Chris Rapley and ran from October 2012 to April 2014. It consisted of a core group, drawn from researchers from psychology, neuroscience, science and technology studies, earth sciences and energy research, together with other members and advisers. It operated through expert cross-disciplinary discussion through regular meetings, a commissioned review of psycho-sociology in the context of psychology and neuroscience, and an experiential event for a trial group of climate scientists to test the impact of exposure to the functioning of human mind and whether it would change the way they worked ("Seeing Yourself See", held in July 2013)

The final report was written by a subset of the core group and reviewed by all Commission members as well as a number of external reviewers.

UCL Public Policy

UCL believes that as a leading university, we have an obligation to ensure that our knowledge and expertise informs the development of public policy. UCL Public Policy is an initiative based in the Office of the Vice-Provost (Research) which seeks to bring UCL's academic expertise to bear on pressing public policy challenges by integrating knowledge and evidence from across disciplines to inform policy. It provides an interface for researchers and policy-makers, facilitates routes for engagement between research and public policy, supports the translation of research into policy-focused outputs, and promotes dialogue and debate on key public policy questions.

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TIME FOR CHANGE ? Climate Science Reconsidered

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