Pictures, scenarios or probabilities: how should we portray dangerous climate change?

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Abstract

"Dangerous climate change" has entered the lexicon of environmental science and policy through its status in the UN Framework Convention on Climate Change as helping to define the ultimate objective of global climate management. But dangerous climate has always been an aspect of human experience and society, manifest through weather hazards. There are different ways in which the idea of dangerous climates can be communicated and this paper identifies three: through pictures, through scenarios and through probabilities. These communication devices are used by different agencies and actors in society, depending on the respective target audiences and the perceptions of efficacy of the different forms of communication. All three approaches play differentiated roles in the social construction of dangerous climate change; and these roles will need to be understood as part of the process of agreeing how the idea of dangerous climate change should contribute to the future evolution of the international climate policy regime. The paper also suggests that an icon-based approach to portraying dangerous climate change may have some potency.

Introduction

In their background paper to this conference, Lorenzoni and Pidgeon (2004) ask: "*How do individuals conceptualise extreme changes in the climate? Do lay people relate to any aspect of [dangerous] climate change by means of thresholds?*" This contribution considers the various ways in which dangerous climate change has been portrayed and communicated in recent years, by science, by analysts and by the media, and how these different forms of portrayal may influence public perceptions of dangerous climate change and the formation of public policy.

Weather has always confronted societies and individual humans with a range of hazards. Hurricanes, ice storms, fog, thunderstorms, dust storms, heatwaves are some of the more obvious ones. Such weather events carry inherent risks for many individuals, for different types of economic activities and for a range of communities (e.g. Figure 1). Climate – simply the time-averaged statistical description of the stream of weather experienced at a place - is therefore also inherently hazardous, or we might say dangerous. Much scientific research and much thinking about new forms of social organisation is directed towards reducing these types of hazards or

dangers – either by reducing exposure (e.g. planning regulation), by alleviating impacts (e.g. disaster preparedness), by increasing resilience (e.g. crop diversification) or by compensating damage (e.g. insurance) (Burroughs, 2004). The emergence of modern weather forecasting in the mid-19th century was itself driven by the desire to predict and forewarn coastal shipping of storm events at sea, events explicitly recognised as dangerous. This experience of climate as dangerous is, however, strongly differentiated across and within societies (Adger and Kelly, 1999).

Figure 1: Cartoon from *The Guardian* newspaper, February 2000, juxtaposing serious flooding in Mozambique with complaints about UK fuel prices.

In contrast to the above perspective, the UN Framework Convention on Climate Change (FCCC) has used the notion of danger in a rather different way. Article 2 – defining the ultimate objective of the Convention - talks about the need to avoid dangerous *interference* with the climate system. While we may indeed already experience aspects of present-day climate as dangerous, interfering with the planetary functioning of the climate system may additionally and distinctively also be dangerous – but in a different way. The formalisation of the notion of dangerous climate change within Article 2 of the FCCC puts the question of "dangerous weather" into a different context; not simply one of hazard alleviation, but one of global climate management. In other words, given that humans are now capable of influencing the behaviour of the planetary climate system, we need some notion of danger to guide our attempts to harness and direct such influence for the common good (or at least to ensure we avert the common bad). This approaches the notion of danger differently from most previous human experience and requires us to think about the Earth System as a whole, to think about defining "dangerous" and "safe" perturbations to that system, and, subsequently, to think about targets to guide international policy.

Article 2 therefore takes our thinking about weather, climate and danger in a different direction from that with which society historically has grappled. This is both good and bad. *Good* because it forces us to think more holistically about the planet, how it functions and delivers weather and climate to different regions, and how sensitive these functions are to human perturbations (i.e., introducing the idea of responsibility and thus liability). *Bad* because it introduces an unhelpful distinction between our long history of learning how to reduce or manage the dangers inherent in any (set of) weather regime(s) and the new challenge of understanding how these existing dangers may be altered by global climate change.

These two approaches to thinking about dangerous climate mirror to a large extent the different approaches of adaptation and mitigation to climate change management. A common approach to understanding adaptation (e.g. Burton et al., 2002) starts with our experience of weather as hazardous (or dangerous) and looks at ways in which such hazards, whether now or in the future, could be reduced. In contrast, a common approach to mitigation (e.g. Mastrandrea and Schneider, 2004), starts with identifying what threshold(s) of change beyond which certain basic functions of the climate system collapse or certain large-scale climate impacts become intolerable. A full reconciliation of these two approaches has not yet been possible.

It is therefore within this context that our current discourse about dangerous climate change takes place. Climate *change* is relevant to both these aspects of danger, namely, (a) the changing severity or frequency of weather events currently perceived as dangerous in different places and by different constituencies (e.g. hurricanes, drought, heavy rainfall), and (b) the emergence of new climatic configurations on the planet, shifts in climate regimes that more fundamentally change the nature and experience of weather in different places (e.g. the collapse of Gulf Stream, the displacement of the Asian monsoon). As short-hand we will refer to these two domains as "danger-as-extreme" and "danger-as-threshold", which perhaps in part reflect the distinction drawn by Dessai et al. (2004) between internal and external definitions of danger.

This paper provides a commentary on how science studies these two domains of dangerous climate change, how science communicates its insights, and how such communication is translated by society and perceived by individuals. It suggests that there are three generic approaches for such communication – *pictures*, *scenarios* and *probabilities*. Each approach is effective as a form of communication depending on the audience and on the objective. The three approaches on the other hand are by no means discrete; all three approaches may be used within the same assessment or communication activity and all three inform and interact with each other in a number of different ways. Within each approach a number of techniques can be used and these are illustrated using a variety of recent examples from science and the poplar media.

Pictures

A BBC TV Horizon documentary, *"The big chill"*, originally screened in the UK in November 2003 is a good example of popular science story-telling using visual media. This documentary advocated the idea that a collapse of the thermohaline

circulation (THC) could occur within 20 years and that the consequences would be immense. Thus,

> "*The conveyor* had *switched off* [in the past]…. *and if it happened before, it could happen again. And if it did, Great Britain would be plunged into a bitterly cold climate*." [Source: Horizon documentary, "*The big chill*", November 2003]

Using powerful visual imagery of snow, ice and cold, the documentary had the undoubted purpose of representing climate change as dangerous, not only for the UK but for the world. Thus,

> "*It could mark the end of the British way of life as we've known it….. It could cause a catastrophe of truly global proportion. Should this scenario ever happen it would bring disaster on an unimaginable scale*." [Source: Horizon documentary, "*The big chill*", November 2003]

The film "*The day after tomorrow*" from producer Roland Emmerich (Figure 2), released in May 2004, went much further in linking abrupt climate change to cataclysmic consequences for the entire planet …

> *"Tornadoes rip Los Angeles, a massive snow storm pounds New Delhi, hail the size of grapefruit batter Tokyo, and in New York City the temperature swiongs from sweltering to freezing in one day. In this special-effects, highly anticipated event motion picture, an abrupt climate change has cataclysmic consequences for the entire planet."* [Source: the pre-release trailer, April 2004].

Figure 2: Publicity image for the film "*The day after tomorrow*".

These portrayals of dangerous climate change, whether through TV or cinema, leave their mark on popular and public perceptions of future climatic risks. They also trigger, often compensating, reactions from the scientific community. The commentary in a recent issue of *Science* (Weaver and Hillaire-Marcel, 2004) explicitly aimed to distance current scientific understanding of global warming and

future climate from the storyline of the Emmerich film. This film generated a stream of public comments, media debates and expert statements about climate change in general and about dangerous climate change in particular. It is more contentious, however, whether such a use of visual melodrama illuminates in any helpful way the scientific understanding of the risks we face due to climate change. A formal study of the impact of such media on individual perceptions and attitudes to dangerous climate change would be informative.

The use of visual imagery to communicate concerns about climate change is of course not new – as illustrated by Brönnimann (2002). He showed that 100 years ago pictures of palm trees and glaciers, sometimes juxtaposed, were used in the popular press to portray the idea of a (in this case longer-term) changing climate. More recently, he suggests, photographs of extreme weather have come to dominate the visual communication of climate change, often by implication communicating the notion of "danger-as-extreme".

Figure 3: "Greetings from London" and "Greetings from the Norfolk Broads". Postcards from a Greenpeace climate campaign ca. 2002.

Motivation for action is one of the implied, or even explicit, objectives of using visual imagery of dangerous climate change. This is illustrated in Figure 3 which shows two of a series of 10 postcards released by Greenpeace in 2002 as part of their joint campaign with the Energy Savings Trust. Such dramatic imagery of extreme climate change is certainly eye-catching. It is questionable, however, whether the above examples help individuals in society make balanced judgements about the risks associated with climate change, or indeed whether such visual images motivates individuals for personal action or changes in behaviour. Recent work in Norwich using citizen surveys and focus groups has shown that for many people there is a significant disconnect between the sort of eye-catching pictures illustrated above and the motivation of individuals to reflect on their own lifestyles (Sophie Nicholson-Cole, pers. comm., May 2004). Indeed, there may even be a subversive dimension to

such portrayals in that the very scale and fear associated with such imagery leaves individuals feeling helpless and even less likely to consider what contribution they can make to providing "solutions".

Scenarios

The scientific implausibility of the narrative behind "*The day after tomorrow*" makes the film inappropriate as a learning device for decision-taking. Not so scenarios. The plausibility of a scenario is essential to its utility to organisations and to decision-makers (e.g. Lorenzoni et al., 2000). Scenario approaches to communicating dangerous climate change ought to adopt more formal and structured ways of developing the key message(s) to be communicated than may be countenanced using visual media. The quality of scenario portrayals of dangerous climate change, however, is still variable.

A recent report into abrupt climate change commissioned by the Pentagon in the US Department of Defense (Schwartz and Randall, 2003), described a scenario which, if realised, would be regarded as dangerous by many. In this story, a warming world causes the thermohaline circulation (THC) in the North Atlantic Ocean to shut down within 15 years, leading to major climatic dislocations across Europe and other world regions.

> *"Recent research … suggests that there is a possibility that … gradual global warming could lead to a relatively abrupt slowing of the ocean's thermohaline conveyor, which could lead to harsher winter weather conditions, sharply reduced soil moisture, and more intense winds in certain regions that currently provide a significant fraction of the world's food production. With inadequate preparation, the result could be a significant drop in the human carrying capacity of the Earth's environment."*
> [Source: Schwartz and Randall, 2003, p.1]

As with the BBC Horizon documentary, the science underpinning this scenario is thin (as highlighted recently, for example, by Broecker, 2004), but the picture created is powerful as much due to the origin of the study – from the military intelligence community of the world's most powerful nation – as to its plausibility. Such narratives draw considerable public, and in this instance political[1], attention and contribute to a popular discourse which can lead to the exaggeration of the potential dangers. The social amplification of risk framework (Kasperson et al., 1988) helps to explain how the exploratory hypothetical idea of a THC collapse triggered by global warming, originally suggested by scientists in the late 1980s, can lead to the exaggeration of the idea in government reports and the dramatisation of the idea in TV documentaries and Hollywood blockbuster films.

Petts et al (2004) use a scenario approach to explore individual attitudes to climate risks and whether or not threshold effects exist in the social perception of rapid climate change. Their three simple scenarios portray rapid climate change as resulting in a warming of either 2.5º or 5ºC over one decade, or else a cooling of

[1] The Global Business Network wrote this report for the Pentagon, thus providing a ready network for its dissemination worldwide.

climate of 2.5ºC over a decade. These are deliberately extreme scenarios which are used to confront individual citizens to elicit attitudes and perceptions of climate change and personal responsibility. Interestingly, the authors found that there was no voluntary association of such extreme scenarios with the idea of danger. "Concern" and "apprehension" were terms used to describe attitudes, but not "danger".

Using historical analogues as the basis for a scenario is another device that can been used to explore people's reaction to extreme weather events, and to potential future changes in their frequency, i.e., to explore "danger-as-extreme". The study by Palutikof *et al*. (2004) used the hot UK summer of 1995 and the warm winter of 1994/95 as two analogue events and undertook a questionnaire survey of several hundred individuals in the UK to identify the perceived risks and benefits of such extreme weather. The results indicated rather ambivalent attitudes to weather extremes in the future. Two thirds of respondents viewed more frequent hot and dry summers would be a pleasant experience for them personally, even though elsewhere in the survey a majority clearly indicated such changes in extreme weather would be a problem for the UK as a whole. This result parallels that of Nicholson-Cole above in drawing attention to the disconnect that exists between perceiving climate change as a large-scale problem or worry, yet often failing to see the incentive for personal action.

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) also addressed the question of dangerous interference with climate through scenario analysis, but fell short of suggesting what level of climate change constituted "danger-as-extreme" or "danger-as-threshold". Instead, the Panel in its Synthesis Report opted to claim the question was out of scope, a value judgement to be made by other bodies and in other fora. Thus:

> "*Natural, technical and social sciences can provide essential information and evidence needed for decisions on what constitutes 'dangerous interference with the climate system'. At the same time, such decisions are value judgements determined through socio-political processes, taking into account considerations such as development, equity and sustainability, as well as uncertainties and risk*." [IPCC, 2001, p.2]

What exactly these socio-political processes are, and how such processes are influenced by science, culture and values, is not immediately obvious. This conference, however, is one contribution to the study of such processes.

Probabilities

The so-called "reasons for concern" diagram from the IPCC Third Assessment Report (Figure 4) provides a bridge between scenario analysis and more formal probability analysis. This diagram portrays five realms of potential climate risk, or reasons for concern, derived from various scenario studies and environmental analyses and relates different levels of climate change, ranging from no change to 6°C or more by 2100, to different qualitative risk levels for each realm. Although the IPCC did not exploit this framework to formalise a definition of danger (as mentioned above), this schematic device has been widely used, cited or adapted by others in subsequent studies and reports to do just this.

One such study is the analysis by Mastrandrea and Schneider (2004) in which they used Figure 4 to quantify the risk of dangerous climate change in a formal probability analysis, with and without climate mitigation policies. Combining an optimising climate-economy model with a cumulative density function derived from Figure 4, from which they impose a threshold for dangerous climate change at 2.85°C of global warming, they conclude that climate policy measures could reduce the risk of dangerous climate change by 2100 from 45% (no policy measures) to near zero. They explore this result under a range of discount rates.

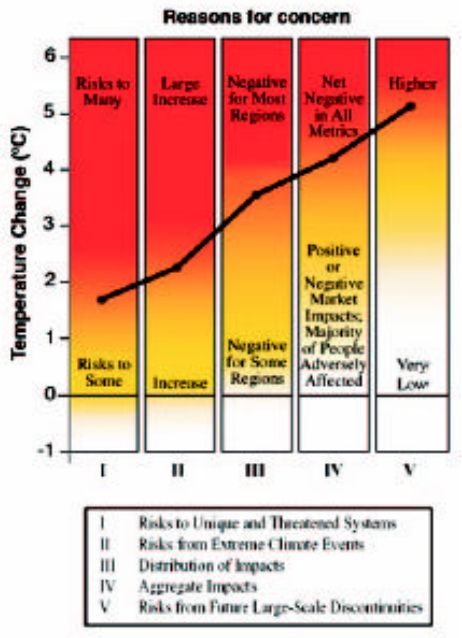

Figure 4: "Reasons for concern" diagram from the IPCC TAR, adapted by Mastrandrea and Schneider (2004) by the inclusion of a cumulative density function using quintiles linked to different global warming thresholds [Source: Mastrandrea and Schneider, 2004].

Another example of using a form of probability analysis to explore notions of dangerous climate change, this time explicitly related to the idea of danger-as-threshold, is the study of Gregory et al. (2004) into the future behaviour of the Greenland ice sheet under different warming rates (Figure 5). They argue that the ice sheet is likely to be eliminated over a period of a few centuries if the local warming over Greenland exceeds 2.7°C. This would add about 7 metres to global sea-level over the next millennium or more, an outcome some may suggest is dangerous. Their analysis shows that of the 35 scenarios they analysed, 34 of them result in such a threshold temperature being reached if annual temperatures are used as the trigger (97% of cases), or 24 if summer temperatures are used (69% of cases). These probabilities of a "dangerous" climate outcome assume no implementation of explicit climate mitigation policies.

Quantifying climate risks in probabilistic terms is necessary for formal risk analysis and this is an approach to climate change management advocated by some (e.g. Jones, 2004). On the other hand, Dessai and Hulme (2004) argue that probabilities are not necessary, or even helpful, for some forms of climate policy-making. Whether or not probabilistic predictions are useful or necessary for policy-making, presenting future

climate risks in probabilistic terms certainly imposes some formal structure on the current status of scientific knowledge. All such attempts, however, rely on a Bayesian approach to quantifying uncertainty (Schneider, 2001) and in some respects therefore leave unresolved the question of how a consensual definition of dangerous climate change may be reached. It is undoubtedly the case however that the Fourth Assessment Report of the IPCC will make more efforts to present knowledge about future climate, including danger-as-extreme and danger-as-threshold, in more probabilistic terms than in previous assessments (Manning, 2003).

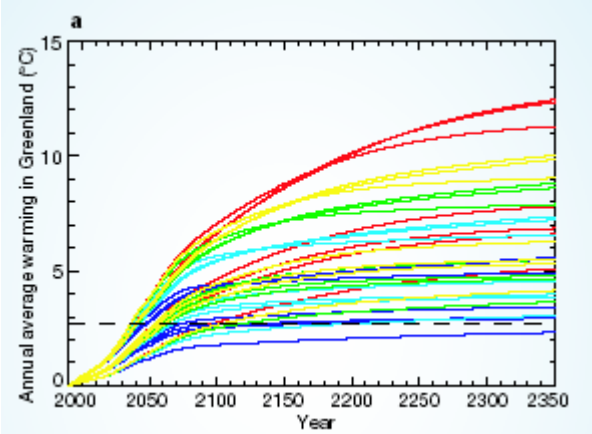

Figure 5: Predicted warming of Greenland over the next few centuries, annual average temperature, for different CO2 stabilisation concentrations and simulated by different models. The horizontal line at 2.7°C is the estimated threshold temperature for ice sheet viability [Source: Gregory et al., 2004].

Discussion

These three approaches to communicating dangerous climate change – pictures, scenarios and probabilities – clearly contribute to the wider public and policy discourses about dangerous climate change in different ways. The approaches clearly inform and transform each other and may be used within the same communication activity. For example, the BBC Horizon documentary uses all three approaches to get its message of danger across – strong visual imagery of icebergs, a (semi-) plausible scenario presented through the narrative of the programme, and the use of probabilities to push home the message. Thus, in the latter case, one of the cited scientists, Terry Joyce from Woods Hole Oceanographic Laboratory, Massachusetts, USA, stated on camera that,

> *"The likelihood of having an abrupt climate change is increasing because global warming is moving us closer and closer to the brink. We don't know where that is … but we're moving towards the edge and so I would say within 100 years its very likely, in other words a 50% probability, that this might happen*." [Source: Horizon documentary, "*The big chill*", November 2003]

A powerful narrative, or scenario, also changes the way in which visual images are interpreted or indeed the way in which events with similar probabilities can be differently interpreted. For example, the 1995 UK summer drought and the extensive

UK river flooding of autumn 2000 were widely and publicly interpreted as representing early indications of human-induced climate change (by implication "danger-as-extreme") using the narrative of global warming and the scenario of such extreme events becoming more frequent in the future. The damaging coastal floods in East Anglia in January 1953 and the 1976 summer drought were *not* interpreted in this way. The extremity of the respective events were similar, the probabilities comparable, and the visual impacts equally striking, but the power of the narrative prevailing in the 1990s, i.e., global warming, ensured that what were interpreted as dangerous weather events in 1953 and 1976, were portrayed as dangerous climate change events in 1995 and 2000.

Although the use of pictures and scenario narratives are influenced by the emergent probabilities that science, or scientists, places on them, these forms of communication often transform the emergent scientific insights and endow them with much greater certainty than is warranted. The collapse of the thermohaline circulation has usually been cited in the scientific literature as a "low probability, high impact" event, even before any quantification of such a statement has been made (whether quantifying the probability or the impact). But such a quasi-probabilistic description of this phenomenon has over the last few years spawned a burgeoning interest in this idea of rapid climate change, being used for political goals (e.g. the Pentagon report), for entertainment purposes (e.g. Hollywood), or to secure additional funding for science (e.g. the £20m RAPID Thematic Programme of the NERC in the UK). It is ironic that two of the scientists who have been most visible in their critique of the Pentagon report and Hollywood film are, respectively, Wally Broecker – who first proposed the mechanism of THC collapse in the 1980s – and Andrew Weaver – a leading ocean modeller whose research has pointed to the unlikelihood of such an event happening in the foreseeable future.

Given the Bayesian nature of the probabilities used in climate prediction, it is inevitable that the wider discourse about dangerous climate change in society will also in turn influence levels of belief amongst scientists about different outcomes, and hence the probabilities that get associated with "danger-as-threshold" events. The increasingly widespread visual representation in society of dangerous climate change will alter the perceived risks of such change occurring, even if the underlying science remains unaltered. The problem implicit in much of this is that the almost subliminal focus on "danger-as-threshold" - the dramatic, the unprecedented - draws attention away from the other dimension of danger, "danger-as-extreme", which is the more everyday experience of dangerous weather which most people have, year in, year out. And here there is a cultural difference also. The majority of the world's population are exposed routinely to dangerous weather and the challenges it brings. It is doubtful whether for such communities the portrayals of climate change as dangerous, whether through pictures, scenarios or probabilities, is as meaningful as for communities in more developed or highly protected societies.

An additional approach to portraying dangerous climate change, which again combines elements of pictures, words and probabilities, and which roots the communication in the more everyday experience of individuals, is the use of icons. This approach would focus on a relatively small number of highly visible climate impacts which had resonance with the public and with policymakers and negotiators. Such selective impacts we call "icons" to make clear that we are not attempting to be

comprehensive and that the choice of impacts is intended to reflect things that matter to individual people. These icons might be natural systems (e.g. the Great Barrier Reef), cities (e.g. the risk of Shanghai being flooded or a hurricane hitting New York), individual species (e.g. polar bears), cultural entities (such as World Heritage Sites), indigenous communities (e.g. the Inuit), etc.

While each icon would be internationally recognised, they would not be viewed as equally important by all. The choice of icons would deliberately prevent all elements being reduced to the lowest common metric – whether dollars, lives, etc. The icons and their vulnerability to climate change would be used to illuminate the implications of policy decisions regarding greenhouse gas stabilisation, encapsulating the issues at stake for policy makers and helping them to define levels of climate change that might be considered dangerous *for specific icons*. This approach would therefore address issues of dangerous levels of climate change without attempting to provide a universal definition of danger based on a single threshold(s) of greenhouse gas concentrations. Each selected icon would be highly visual (allowing communication through pictures), the vulnerability of each icon to different levels of climate change could be communicated through narratives (scenarios), and the use of formal probabilistic prediction techniques would allow communication and analysis of danger using risk-based methods. Different constituencies – media, public and policy - could be served by this approach and the icon-based approach would relate notions of danger to phenomena or assets which had immediate saliency with everyday experience.

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