



Problems with making and governing global kinds of knowledge[☆]

Mike Hulme

School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, United Kingdom

ARTICLE INFO

Article history:

Received 2 June 2010

Received in revised form 8 July 2010

Accepted 8 July 2010

Keywords:

Climate change

Knowledge

Geography of science

IPCC

Cosmopolitanism

ABSTRACT

During its 20 years of publication, the journal *Global Environmental Change* has given visibility and coherence to the eponymous research paradigm. Global environmental research has brought forth new kinds of knowledge about the multi-scale interactions between physical and social dimensions of the environment. This essay reflects on some of the problems with making and governing these global kinds of knowledge, as suggested through the perspectives of a nascent geography of science. I use climate change – an emblematic theme of global environmental change research over the last 20 years – to examine three facets of the global environmental change paradigm: making global kinds of knowledge, globalising environmental values and the governance of knowledge-making. New global kinds of knowledge have gained power and visibility in contemporary scientific, public and political fora and yet such knowledge can be 'brittle', easily cracked and broken. A geography of global environmental change knowledge therefore demands we turn our attention away from the globalising instincts that so easily erase difference and collapse meaning, and instead concern ourselves with understanding the relationships between knowledge-making and human culture in evolving places. Only then will we recognise the ambiguities, voids and blind spots in our understanding of the world's complexity.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

The first issue of the journal *Global Environmental Change (Human and Policy Dimensions)* appeared in December 1990, just a few months after the publication of the First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The inaugural issue included three essays which explored the contours of the new global environmental change research paradigm. Geographers Martin Price and Billie Turner suggested that the challenges of designing and executing global environmental change research were primarily linked to the integration of disciplines (Price, 1990) and of scales (Turner et al., 1990). Sociologist Fred Buttel looked critically at the ways in which the emerging science around climate change – already seen as an (the?) exemplar of global environmental change – was being harnessed to wider social and political ideologies (Buttel et al., 1990). The themes of these three essays – the integration of disciplinary knowledge, the multi-scale relationships between social and physical processes and the complex relationships between knowledge and policy – have remained central in the subsequent development of academic research and policy debates concerned with global climate change.

Each of these three pioneering essays concluded with warnings about the challenges ahead for global environmental change research; and they each issued calls for the social sciences to be centrally placed in the framing and executing of such research. Turner et al. (1990), for example, problematised the idea of 'the global'. They explained how it could refer equally to globally systemic change or to local changes that are globally cumulative. These authors argued for clarifying definitions 'at an early stage to prevent much later confusion' (p. 21). Their call for social sciences to be centrally engaged emerged from their recognition that '... the social and cultural differences across space would mediate differently the human impacts of even a uniform global physical change' (p. 21).

Price (1990) laid out a number of future directions for interdisciplinary research programmes around global environmental change, including '... the need for evolution towards trans-disciplinarity, i.e. interactions not only between disciplines, but also with planners, administrators and local populations' (p. 13). Again, greater involvement of the social sciences was called for, Price arguing that '... much previous [social science] work on human responses to [local] change ... is applicable to issues of global environmental change' (p. 13). Buttel et al. (1990) identified a different challenge and warned of the dangers of the global environmental change paradigm conflating '... a scientific concept [with] a social movement ideology'. They suggested that global change was one of a growing number of instances of 'scientised

[☆] Essay for 20th anniversary issue of *Global Environmental Change*.

E-mail address: m.hulme@uea.ac.uk.

policy' and 'politicised science', and argued from the standpoint of the sociology of science and knowledge that '... global change stands in need of social science inquiry that takes a detached, critical and cautionary view' (p. 66).

Over the subsequent 20 years, global environmental change has developed as a research paradigm in a number of ways. There have been significant conceptual advances, many of them reported in this journal: for example understanding climate change as social vulnerability (Bohle et al., 1994), introducing the perspective of resilience into socio-ecological systems analysis (Folke, 2006) or linking global environmental change with environmental history (Costanza et al., 2007a; Hornberg et al., 2007; Cornell et al., 2010). And new topics of investigation – such as world food trade (Fischer et al., 1994), virtual water flows (Hoekstra and Hung, 2005) and the phosphate cycle (Cordell et al., 2009) – have been pursued using the framework of the human and policy dimensions of global environmental change.

Yet despite this deepening and widening of research activity, the difficulties identified by Price, Buttel and Turner back in 1990 remain entrenched. In a recent meta-analysis of 20 scientific assessments across various global environmental change themes, Weichselgartner and Kaspersen (2010: 276) conclude with a statement which seems to suggest little advance beyond Price's observations in 1990:

Today, there is broad agreement that more integrative assessments are needed. However, less consensus exists on *what* needs to be integrated and *how* that integration should be accomplished. Suggestions range from the integration of scope, research methods and scale, to disciplines and stakeholder involvement ... [but] only a fifth of the case studies analysed attempt to integrate practical elements [or] consider socio-economic and geophysical aspects across spatial scales.

And in the specific context of global climate change, Szerszynski and Urry (2010) have recently remarked how the social sciences (apart from economics) have been mostly absent from the analysis of global climate change risks, where '... the social is both central and yet pretty well invisible' (emphasis in original).

In this essay to mark the 20th anniversary of the journal, I wish to reflect on one specific aspect of the 'science and ideology' (*à la* Buttel) of global environmental change which in my view has not been sufficiently scrutinised by critical social scientists, namely: 'How have the new kinds of knowledge about global environmental and social changes been made, and how have these knowledge-making institutions been governed?' My concern is with the diminishing, or even erasing, of a geographical sensibility in the making, mobilising and consumption of knowledge about global environmental change—for example downplaying cultural difference or ignoring spatial relationships of power. I am sensitised to this concern through following the trails of enquiry being laid down by the new geographers of science.

2. Geographies of science

The recent spatial turn in the sociology of knowledge (Ophir and Shapin, 1991; Shapin, 1998; Powell, 2007) is more than simply recognising space as another factor – like time or technology – in the making of science. It is more about answering the questions, as put by David Livingstone (2005: 100): 'How do *particular* spaces matter in the production, consumption and circulation of science? ... At what scale of analysis is the delivery of an identifiable set of scientific claims to be apprehended?' (emphasis added). Being sensitive to the (historical) geographies of science unveils relationships of power in the ways scientific knowledge is made, mobilised and valorised. It is this perspective which has led to

nascent geographies of science being written to complement the histories, philosophies and sociologies of science.

Subjecting scientific knowledge to geographical enquiry helps us to distinguish between the universalising drive of scientific enquiry and what I call here the instinct to make global kinds of knowledge. Universal knowledge claims to be 'true' irrespective of scale and place, for example our understanding of the radiative properties of carbon dioxide molecules in the atmosphere. Truth becomes, in Steven Shapin's memorable phrase, 'the view from nowhere' (Shapin, 1998: 5). Globalised knowledge, which I wish to explore here, is different however. It is knowledge which erases geographical and cultural difference and in which scale collapses to the global. Rather than the view from nowhere, global kinds of knowledge claim to offer the view from everywhere.

The path I follow then is *not* the one Turner et al. opened up in their 1990 essay when they drew attention to the difficulties of predicting '... the social and cultural differences across space [that] would mediate differently the human impacts of even a uniform global physical change' (p. 21). I am not engaging here with arguments about whether or not human agency and culture should be represented in global models and how such representations should be achieved: for example through simulation of agent-based behaviours or through capturing the dynamics of social change (see Costanza et al., 2007b). There are indeed important matters of philosophy and epistemology here for global environmental change researchers to debate.

My attention is focused, however, on revealing the globalising instincts of knowledge construction about environmental change and on exploring the role geographical difference and spatial relations plays in the governing of such knowledge-making. Knowledge about multi-scalar processes and globally-aggregated outcomes that is insensitive to the peculiarities of place and context opens the way for unitary globalised explanations and predictions of environmental change. Masquerading as universal truths, these assert themselves as the unassailable view from everywhere. Such claims in turn lend support to managerial instincts that seek to centralise political power and social control (Scott, 1998). But such outcomes may not necessarily be self-evident public 'goods' and they certainly raise questions about who owns and controls the future (Anderson, 2010).

There are a number of ways in which these globalising instincts in the making and governing of knowledge about global environmental change can be examined. To focus my argument I follow just one of the themes with which the global environmental change research paradigm is concerned: climate change—perhaps still the most emblematic of topics and certainly the one which retains the greatest scientific, political and public saliency. I conduct my examination by looking at three facets of research conducted in this domain: making global kinds of knowledge, globalising environmental values and the governance of knowledge-making.

3. Making global kinds of knowledge

The clearest example of the globalising instinct in the making of climate change knowledge is the reification of global-mean temperature. This indexed quantity – whether constructed from thermometer measurements, calculated from satellite retrievals, reconstructed from proxies or modelled through computer code – is central to the language of climate change (and, by association, of global environmental change). It has gained iconic status in scientific, policy and public discourse.

This index of global climate performs multiple functions. It *reveals* the extent of past change in globalised climate: a planetary warming of between 0.74 °C and 0.80 °C since the mid-nineteenth century. It *acts* as the locus for scepticism and ideological combat

about public narratives of climate change: the controversy about the hockey-stick shape of the reconstructed millennial (hemispheric) temperature series. It offers a number around which the normative goals of international climate diplomacy can be stabilised: witness the citation in the Copenhagen Accord of 2 degrees Celsius as the increase in global-average temperature below which climate change 'should be' limited. And it affords an indexed storyline along which the meaning of future climate change in popular imagination can be narrated: as in Mark Lynas' account of worldwide climate change impacts in his book *Six Degrees* (Lynas, 2007). The story of global climate has in many senses become the story of global temperature.

Why and how has global-mean temperature gained such ascendancy? Clark Miller has offered one account of how the idea of climate evolved from being interpretative, and hence geographically differentiated, to becoming enumerated and hence readily globalised (Miller, 2004). The post-1950s era of satellites and computer models and a globally connected network of scientific institutions and practices enabled this new construction of climate to emerge. Climates plural became global climate singular, regional climate variations became global climate change, and global climate change became the systemic entity that was to be predicted by the new Earth System science.

The appearance during the 1980s of the first credible indices of global-mean temperature (Hansen et al., 1981; Jones et al., 1986) helpfully offered scientists, politicians and campaigners an easily recognisable signature of this newly conceived climate system. The veracity of computer models of climate could be tested against this singular index of globalised climate performance, while the human influence on climate could be discovered through detection and attribution studies which used the trend in global temperature as 'the smoking gun' (e.g. Wigley and Raper, 1991). And beyond mere scientific convenience, political and ethical arguments about desirable and undesirable globalised climate states could be gathered around the performance of this one index (see Tol, 2007; Randalls, 2010).

But collapsing human knowledge about climate change into one global signature hides far more than it discloses. It is psychologically sterile: no-one experiences or witnesses global-mean temperature and it requires extraordinary efforts of the imagination for it to acquire purchase in the practices of everyday living. It offers an inadequate and one-dimensional guide to policy: the putative international policy goal of two degrees of warming is deeply ambiguous with regard to 'allowable' emissions of greenhouse gases and other forcing agents. And it is increasingly recognised as severely limiting the framing and goals of scientific enquiry. Stott and Thorne (2010: 158) have recently observed that the late twentieth century effort of constructing an index of global temperature has been superseded: '... a new question needs to be answered: how exactly will the climate change from place to place?'

Through bringing a new kind of knowledge about climate into circulation, 'global temperature' neglects the many other possible regional or local signatures of a changing climate that are of far greater importance for mobilising and constraining society and resources: for example the Asian or African monsoons, El Niño events, Caribbean hurricanes, the French mistral. Geography – apprehending difference, heterogeneity and complexity in the interactions between societies and natures – thus gets crowded out by the dominant construction of globalised knowledge and discourse around climate change.

The global temperature index is suggested here as a motif of a wider globalising instinct in the contemporary making of knowledge about environmental change. The 'panoptic gaze' offered by global climate models (Barnett et al., 2009), the nine global planetary boundary conditions used to define sustainability

(Rockström et al., 2009) or the construction of global indices of human vulnerability to climate change would be other examples. These are all de-contextualised, top-down views of planetary knowledge, knowledge-making detached from meaning-making according to Jasanoff (2010). It is the view from everywhere.

The modes of such knowledge-making pay little attention to the multiple ways of knowing environments, of living in places and of imagining the future which are embedded in local cultural practices and knowledge-making traditions. And the discourses of sustainability, survival or decline – even when applied to specific peoples, places and cultures – are forced to use the new vocabulary which emerges from global kinds of knowledge. The danger here is that place-based knowledge is marginalised from the dominant centres of global knowledge production and mobilisation or, as Radcliffe et al. (2010: 102) remark, '... epistemological violence can be done to different places and peoples as they come to symbolize and exemplify certain parts of the wider environmental storyline'. *The People's Agreement* – the declaration from the World People's Conference on Climate Change and the Rights of Mother Earth, held in Bolivia in April 2010 – shows how alternative kinds of knowledge about global environmental change can be mobilised. The declaration enshrines the rights of peoples to control their own seeds, lands, water and food production, thereby guaranteeing access to sufficient and nutritious foods 'through forms of production that are in harmony with Mother Earth and appropriate to local cultural contexts.'¹

4. Globalising environmental values

The globalising instinct so prevalent in the knowledge and discourse of much global environmental change research can also be found through the erasure of difference in how the environment – or, in the case considered here, climate – gets valued. Economists of course see it as their unique role to reduce heterodox and incommensurate human values to uniform monetary expressions. Within climate change this instinct has perhaps been most evident in the *Stern Review* (2007). Here, in a deliberate attempt to argue a case for climate change policy based on an appeal to a universal economic discipline, the risks associated with climate change over the next 200 years were converted into the single metric of globalised monetary value.

Little attention was paid in the *Stern Review* to variations across different cultures and countries in the valuation of climate risks and no effort was made to establish or value the different cultural functions that climates play in different places. By claiming that unmitigated climate change imposes a cost on the global economy of between 5% and 20%, in perpetuity, the Review achieved what it set out to achieve: a convincing economic argument for strong (global) mitigation actions based on a clear-cut (globalised) cost-benefit comparison. The *Stern Review* was aware of these limitations and subsequent analysis brought out more fully the implications of this globalised analysis (e.g. Neumayer, 2007; Sterner and Persson, 2008). These debates about globalised values echoed earlier controversy about the 'value of a statistical life' in the Second Assessment Report of the IPCC in 1995 (see Fankhauser et al., 1998) and parallel on-going debates about the relevance of universal ethics versus situated ethics, for example in the application of biotechnology (e.g. Greenough, 2007).

Globalising human values through erasing geographical and cultural difference offers questionable benefits and introduces abundant dangers. Scaling-up to the global allows '... the new global environmental change agenda [to] 'trump' local processes and agendas, especially more complex political ones' (Radcliffe

¹ This conference statement can be read at <http://pwccc.wordpress.com> (accessed 6 July 2010).

et al., 2010: 103), while Sheila Jasanoff (2010: 236) has pointed out that this homogenised understanding of climate change ‘detaches global fact from local value, projecting a new, totalising image of the world as it is, without regard for the layered investments that societies have made in the worlds as they wish them to be. It therefore destabilises knowledge at the same time that it seeks to stabilise it.’

This is a line of criticism in global environmental change research which has been pursued in other contexts and by other authors. Adger et al. (2009), for example, in their investigation of social limits to adaptation draw attention to the ‘systematic undervaluation’ of places and cultures in the economic calculus underlying much adaptation work: ‘... the current metrics of accounting for loss do not include mechanisms for evaluating the cultural and symbolic value of the landscape’ (p. 349). These are places and cultures that have values and meanings for people that are hidden from the view of global climate or economic models.

Barnett and Campbell (2010) are similarly critical of Stern’s globalising metrics which are blind to the nuances of people and cultures residing in unique places. In their critical enquiry into climate change and small island developing states they show how Pacific islands are treated as uniform objects, being portrayed as vulnerable, powerless and ignorant. Small islands frequently are given merely symbolic value as icons of vulnerability to climate change. Even when their presence is recognised in global cost-benefit calculations, the economic value ascribed to them emerges from aggregate models constructed by external experts:

... this cadre of [climate change] experts, from atmospheric and integrated assessment modellers through to mainstreaming adaptation planners ... seem to circulate in a science-policy bubble that at times floats far above the places where impacts will be felt and adaptations required. The bubble is an intense and preoccupying place, where climate change tends to dominate everything ... (Barnett and Campbell, 2010: 179)

By placing a single global value on the ‘stability’ of a single index of climate – global temperature – these new kinds of global knowledge open the way for managerialism on a planetary scale. The culmination of this ideology would be establishing a global thermostat—a control technology for the purpose of optimising global temperature according to a unitary global economic calculus. Such technologies are beginning to be researched (Royal Society, 2009; also see below) and yet such deliberate intervention in planetary functions demands that everything that humans value be entered into one single planetary account. Difference is erased and the global assimilates the local.

5. Governance of knowledge-making

Intimately related to new kinds of knowledge about global environmental change and to the global economic calculus of loss and gain is the governance of international institutions which enable and endorse these globalising practices. Recognising and understanding the new institutions that have grown up around the paradigm of global environmental change is therefore important. In the years between 1994 and 2004, *Global Environmental Change* carried occasional short articles describing or analysing ‘institutions for global environmental change’, a section of the journal edited by Tim O’Riordan and Andrew Jordan (e.g. Jordan and O’Riordan, 2004). In my two previous examples I used the global temperature index and the Stern Review as emblematic of these instincts at work in the case of climate change. Here, the relevant example to use is the IPCC, an international institution which has become dominant in the making and validating of knowledge about climate change.

The IPCC has recently come under considerable scrutiny, triggered early in 2010 by the exposure of a small number of embarrassing errors and careless referencing in its Fourth Assessment Report (Schiermeier, 2010; PBL, 2010). It was a problem exacerbated by the rather less than assured and speedy response from the IPCC leadership (Bagla, 2010). The credibility of aspects of global climate change knowledge was publicly challenged and the legitimacy and integrity of some of the IPCC’s processes of knowledge assessment were questioned. One of the supervising agencies for the IPCC – the United Nations Environment Programme – subsequently commissioned the Inter-Academy Council to conduct an independent inquiry into the knowledge-making practices of the institution.²

These troubled waters for the IPCC illustrate the argument I wish to make here: it is easy for global institutions of knowledge-making to become insensitive to a geographical sensibility. As Miller (2004, 2007) and Jasanoff (2005, 2010) have argued, the making of global kinds of knowledge through new institutional arrangements is intimately tied to the political and social ordering that accompanies that knowledge-making. Knowledge about global environmental change – in the case I am examining here knowledge about climate change – which seeks international recognition and political assent, is knowledge that comes into being only in particular institutional settings. These are settings in which power relations between different nation states and between national governments and non-governmental civic actors are configured in certain ways, in the case of the IPCC according, respectively, to UN principles of national sovereignty and the intergovernmental governance of the IPCC process.

The IPCC is different in this regard to, say, the Millennium Ecosystem Assessment (Leemans, 2008). Understanding the validity and durability of the new kinds of knowledge about global climate which are thereby made, requires an understanding of these specific configurations of power. Or, as Miller (2007: 327) has recently put it, it is necessary to understand ‘... the precise mechanisms by which international institutions produce and validate knowledge claims and translate their expertise into power and authority—[i.e.] to attend closely ... to knowledge-making as well as decision-making processes in international governance’ (emphasis in original).

There are questions here to be asked about the new civic epistemology – ‘a set of evidence, facts, logics, rationales, and styles of reasoning on which to ground policies that encompass the globe’ (Miller, 2007: 350) – of global climate change which the IPCC has brought into being. The recent challenges to the authority of the IPCC – whether those implicit in *The People’s Agreement* which implies that indigenous was of understanding climate and its impacts are not reflected in IPCC reports or those that sought to exploit errors in the Fourth Assessment Report to argue against climate policies³ – are therefore part of a struggle to gain power and influence in the new global politics of climate change knowledge. For example, Kandlikar and Sagar concluded their 1999 study of the North–South knowledge divide by arguing, ‘... it must be recognised that a fair and effective climate protection regime that requires cooperation with developing countries, will also require their participation in the underlying research, analysis and assessment’ (p. 137).

² The United Nations announced on 10 March 2010 that the Inter-Academy Council – a multinational organisation of science academies – would conduct this independent review of the IPCC’s procedures for preparing assessment reports. It was to report to the United Nations by 30 August 2010.

³ The error that gained the most attention was the mistake made in Chapter 10 of Working Group 2 of the IPCC’s Fourth Assessment Report in which it was claimed that Himalayan glaciers may have entirely disappeared by 2035 or perhaps sooner. This error created space for subsequent criticisms to be made by a variety of interests and commentators against the IPCC and its assessment of climate change knowledge.

One example of this specific geographical configuration of power therefore concerns the spread of expertise mobilised by the IPCC assessments with respect to the participation of developing country experts (Karlsson et al., 2007). Despite increasing attention paid by the IPCC governing bureau to these concerns since they were first expressed in the early 1990s (and which continue to be expressed; e.g. Demeritt, 2001; Grundmann, 2007), the proportion of IPCC authors and reviewers from OECD versus non-OECD countries has barely changed. In each of the Second, Third and Fourth Assessments Reports of the IPCC, the percentage of authors, review editors and expert reviewers from the OECD nations has remained remarkably constant at between 80% and 82% (Hulme and Mahony, 2010).⁴

This geography of IPCC expertise has consequences, whether for the construction of IPCC emissions scenarios (Parikh, 1992), the framing and shaping of climate change knowledge (Lahsen, 2007) or the legitimacy of the knowledge assessments themselves (Elzinga, 1996; Mayer and Arndt, 2009). This latter critique is voiced clearly by Myanna Lahsen (2004) in her study of Brazil and the climate change regime: 'Brazilian climate scientists reflect some distrust of . . . the IPCC, which they describe as dominated by Northern framings of the problems and therefore biased against interpretations and interest of the South' (p. 161).

The struggle over the governance of global knowledge-making processes is only likely to become more intense. Climate change knowledge claims are increasingly called upon to justify new policies and technologies which seek managerial control of the Earth's climate. The embrace by parts of the corporate sector of market environmentalism and its reliance on carbon markets is one such ideological project, while a more recent example concerns the deliberate intervention with the solar radiation flows into the planet. There is a growing movement of scientists, technologists and policy-analysts which seeks to undertake large-scale technological interventions in the global atmosphere. The express intention is to manipulate the world's heat budget to ensure some desirable global climate state (Blackstock and Long, 2010). Any adequate risk assessment of such a project would rely on much more than the reliability of merely global kinds of knowledge – the aggregated response of the Earth system to deliberate intervention. It would require understanding the ways that response is manifest and conditioned at local scales and how the attribution of any ensuing regional climate anomalies to the original intervention would be subsequently contested (Bunzl, 2009).

In this context, Clark Miller's general observation about the governance of global knowledge carries a warning to those involved in the making of knowledge, whether knowledge about global environmental change in general, or global climate change in particular:

... the opening up of international governance to greater deliberations among a wider array of actors has contributed, perhaps not surprisingly, to an increasing preoccupation with struggles over the truth status of knowledge claims and the resources for making those claims more or less believable to diverse publics (Miller, 2007: 330).

The various projects to manage the world's climates, most recently and notably the new discourse of solar radiation management, are ideologically-loaded and carry with them

⁴ The author and review editor lists (excluding expert reviewers who are of course not yet known) for the IPCC Fifth Assessment Report announced June 2010 have a slightly lower proportion of OECD authors. OECD authors comprise 77% (90%) for Working Group I, 64% (69%) for Working Group II and 65% (70%) for Working Group III (equivalent Fourth Assessment Report percentages in parentheses).

implicit forms of political and social order. As new kinds of global knowledge are enlisted in support of these various projects, more critical reflection is called for from those who are engaged in the processes of such knowledge-making and governing. Global environmental change researchers need to be sensitised to the new geographies of science.

6. Re-thinking the kinds of knowledge we make

Making new kinds of global knowledge about climate change – and I argue by extension about global environmental change in general – has carried great promise. The original 1988 mandate to the IPCC, for example, was to forge a scientific consensus about the impacts of human activities on global climate for the benefit of policy-makers around the world. Global temperature and global climate models became essential components of this consensus-making. Inventing a stable global climate as a public good has been made possible through the globalised valuing of climate change risks and has opened the way for market incentives to be designed with the promise of altering patterns of production and consumption. And at least in the eyes of some commentators, new international institutions of knowledge-making such as the IPCC offer new centres of power through which political actors operating beyond the reach of the nation state can be held to account.

Yet at least some of these new kinds of global knowledge about climate change have a 'brittle' feel to them; they may appear solid and firm to touch, but they may easily crack under pressure and lose efficacy in a plural and turbulent world. Worse still, they may distort reality and reduce local agency (see Barnett and Campbell, 2010, for an example of this). Scientific knowledge about global climate and its past and future behaviour often seems remote or detached from the diverse geographies of personal or collective history and culture. The economics of climate change similarly are in danger of erasing vital geographical differences in the personal or collective valuations of material and symbolic goods. And new international institutions of global knowledge-making and propagation such as the IPCC may end up only very weakly anchored in any trans-national democratic accountability. To adapt the metaphor of 'thick' descriptions of human behaviour (Geertz, 1973), these new kinds of global knowledge can turn out to be 'thin and flat'.

In contrast to this brittle kind of global knowledge, attending more carefully and deliberately to geographical sensibilities in the making and governing of kinds of knowledge suggests some different perspectives. Rather than consensual and global approaches to knowledge-making about global environmental change, we perhaps need to consider spectral and cosmopolitan approaches to knowledge-making. Spectral knowledge can be thought of in two ways. It is spectral in that it more explicitly captures and communicates the full range of expert beliefs about how the world is and may become, rather than valorising consensus. This may be cumbersome and clumsy, but it better captures the ambiguities in the human search for warranted truth. And knowledge about climate change can also be spectral in the sense that it recognises and respects geographical and cultural differences in the ways different forms of knowledge come to be granted authority in public life (Jasanoff, 2005).

A further way of critiquing the global kinds of knowledge being created is by adopting Ulrich Beck's cosmopolitan perspective on the world. In their essay in the first issue of *Global Environmental Change*, Turner et al. (1990) offered two ways of thinking of the 'global' in global environmental change: either change that is globally systemic or local changes that are globally cumulative. The driving concepts were, respectively, a unifying scale and spatial aggregation. But for Beck (2006, 2010), cosmopolitanism is a world without boundaries: whether between states, markets, cultures

and, we might add, epistemologies. Although borders persist, they are weakened and people, capital, brands and ideas flow more freely than before. It is a world of fluid heterogeneity, where scale becomes transient and Cartesian space easily subverted. Cosmopolitanism blurs and dissolves distinctions between global and local, between quantitative and qualitative knowledge. It greatly expands the range of risks, goods, ways of life and knowledge that humans encounter.

What might this perspective signify for approaches to knowledge-making and especially the global kinds of knowledge I have critiqued above? A cosmopolitan approach to knowledge would recognise its place- and context-shaped characteristics, but also its intense mobility. It would recognise the diversity of knowledge in the many different worlds people now inescapably live in and are exposed to. A cosmopolitan perspective allows local and situated knowledge about multi-scale environmental changes to become globally visible, but does so without requiring it to conform to a single globally integrative framework. Indeed, as knowledge travels around a cosmopolitan world, its original characteristics can mutate into new forms. A cosmopolitan approach requires a worldwide perspective on forms of knowledge-making and knowledge mobility, but it does not flatten-out or collapse knowledge thus made. Neither would a cosmopolitan understanding be blind to cultural differences in the social authority inscribed in different forms of knowledge.

Rather than 'global systemic change' or 'local changes that are globally cumulative' being the hallmarks of global environmental change knowledge (*à la* Turner et al.), a cosmopolitan perspective would suggest the 'global' is less about scale or aggregation than it is about embracing plurality in the making, accrediting and mobilising of knowledge. It is about transcending the glass walls we erect between disciplines and between our interior and exterior worlds. In such a cosmopolitan world, knowledge is made liquid and versatile, rather than solid but brittle. Liquid knowledge is able to move and flow freely around the world, and in this sense becomes global, but is readily able to absorb new substances – perspectives, values, meanings – as it does so.

I have explored elsewhere (Hulme, 2010) how Beck's vision of the cosmopolitan may help us re-think the idea of climate change. The scientific narrative of global climate change – and its regional manifestations – becomes entangled with the animated personal (direct or vicarious) experiences of local weather:

New categories of cosmopolitan climates are thereby created, categories more satisfying than those of global climate because they allow the spatial distinctions between the global and the local to be dissolved. The anonymity and remoteness of narratives of global climate change is subverted by re-inventing localised narratives of warming and change to which we have greater psychological attachment. Yet the consequence of such cosmopolitan tendencies . . . is that climate change takes on a multiplicity of meanings and evokes an irrepressible variety of emotions. There is an unruliness in the human experience of weather which undermines any global project for climate manipulation and control (Hulme, 2010: 273).

From a cosmopolitan perspective, the world does *not* have one global climate, just as it does not have one culture, one set of values or one political instinct. Rather, the world possesses a multiplicity of climates and a multiplicity of cultures, values and ways of life. There are no global pathways to the future because the world does not walk together; we walk along different paths towards different destinations. Rather than seeking a consensual global knowledge which erases difference and allows the most powerful to determine what is 'known', we need to pay greater attention to the different ways knowledge comes to be made in different places and how

different kinds of knowledge gain hold in people's minds, traction in different cultures and assent in global fora. This is spectral knowledge which emerges from a cosmopolitan perspective.

Dan Sarewitz has drawn attention to one of the limitations of thinking in flattening ways about global knowledge. In his commentary on how science is used to reduce the vulnerability of poor countries to earthquakes, he criticises the Global Earthquake Model funded by the OECD which offers a global tool to solve a problem irrespective of what the problem demands: 'This approach reflects a great fallacy of the modern ideology of science: that scientific knowledge is a public good, equally available and potentially equally beneficial to all. But knowledge that is useful – and used – is knowledge that emerges within a particular social and institutional context' (Sarewitz, 2010: 29).

7. Conclusion

The move to create global kinds of knowledge – whether global earthquake or climate models, whether global indices of temperature or human vulnerability – shapes the world in particular ways. Global kinds of knowledge yield global kinds of meaning-making and policy-making. They erase cultural differentiation and heterogeneity. They fail to do justice to the plurality of human living and may have considerably less purchase in problem-solving and policy-making than a multiplicity of local and diverse tools and indicators. As geographers Sarah Radcliffe and Liz Watson explain: 'Simplified [global] models can give decision-makers a false sense of confidence that the problems are easy to identify and the solutions straightforward to implement' (Radcliffe et al., 2010: 104). In contrast, incomplete, spectral and cosmopolitan kinds of knowledge make it easier to imagine and design the polycentric approaches Eleanor Ostrom calls for in handling some of the world's most concerning dilemmas. Ostrom (2010) argues that polycentric approaches to institution-building and policy-making facilitate experimentation and learning across multiple scales. I suggest that there is an important corollary of this argument for knowledge-making.

Processes of knowledge-making are intimately bound up with the assumptions about political and social ordering which lie implicit in the institutions which enable and endorse this knowledge. This is true for all knowledge-making, but especially so with the kinds of global knowledge enabled by new institutions of global environmental change research. A geography of global environmental change knowledge therefore demands, rather paradoxically, that attention turns away from the globalising instincts that so easily erase difference and which seek consensus. Instead, attention should focus on understanding the changing relationships between knowledge-making, institutional practice and human culture in evolving places. We need kinds of knowledge which are 'liquid' – i.e. mobile and responsive – rather than 'brittle' – i.e. thin and flat. These kinds of liquid knowledge will accommodate more easily – and emphasise more readily – the ambiguities, voids and blind spots in our understanding of the world's complexity. And in a pluralistic, poly-centred world they may prove fitter for a wider range of purposes.

Acknowledgements

The constructive comments and suggestions of two anonymous reviewers are acknowledged.

References

- Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D., Otto-Naess, L., Wolf, J., Wreford, A., 2009. Are there social limits to adaptation to climate change? *Climatic Change* 93, 335–354.

- Anderson, B., 2010. Preemption, precaution, preparedness: anticipatory action and future geographies. *Progress in Human Geography*, doi:10.1077/0309132510362600 (on-line).
- Bagla, P., 2010. Climate science leader Rajendra Pachauri confronts his critics. *Science* 327, 510–511.
- Barnett, J., Campbell, J., 2010. Climate Change and Small Island States: Power, Knowledge and the South Pacific. Earthscan, London, 218 pp.
- Barnett, J., Christoff, P., Rangan, H., Sutherland, E., 2009. An inconvenient truth (2006) review symposium. *Geographical Research* 47 (2), 204–211.
- Beck, U., 2006. *Cosmopolitan Vision*. Polity Press, Cambridge, 216 pp.
- Beck, U., 2010. Climate for change, or how to create a green modernity? *Theory, Culture & Society* 27 (2–3), 254–266.
- Blackstock, J.J., Long, J.C.S., 2010. The politics of geoengineering. *Science* 327, 527.
- Bohle, H.G., Downing, T.E., Watts, M.J., 1994. Climate change and social vulnerability: toward a sociology and geography of food insecurity. *Global Environmental Change* 4 (1), 37–48.
- Bunzl, M., 2009. Researching geoengineering: should not or could not? *Environmental Research Letters* 4, doi:10.1088/1748-9326/4/4/045104.
- Buttel, F.H., Hawkins, A.P., Power, A.G., 1990. From limits to growth to global change: constraints and contradictions in the evolution of environmental science and ideology. *Global Environmental Change* 1 (1), 57–66.
- Cordell, D., Drangert, J.-O., White, S., 2009. The story of phosphorus: global food security and food for thought. *Global Environmental Change* 19 (2), 292–305.
- Cornell, S., Costanza, R., Sörlin, S., van der Leeuw, S., 2010. Developing a systematic “science of the past” to create our future. *Global Environmental Change* 29 (3), 426–427.
- Costanza, R., Graumlich, L.J., Steffen, W. (Eds.), 2007a. *Sustainability or Collapse? An Integrated History and Future of People on Earth*. MIT Press, Boston MA, 520 pp.
- Costanza, R., Leemans, R., Boumans, R.M.J., Gaddis, E., 2007b. Integrated global models. In: Costanza, R., Graumlich, L.J., Steffen, W. (Eds.), *Sustainability or Collapse? An Integrated History and Future of People on Earth*. MIT Press, Boston, MA, 520 pp., pp. 417–446.
- Demerit, D., 2001. The construction of global warming and the politics of science. *Annals Association American Geographers* 91 (2), 307–337.
- Elzinga, A., 1996. Shaping worldwide consensus. The orchestration of global change research. In: Landström, C. (Ed.), *Internationalism and Science*. Taylor Graham, London & Los Angeles, pp. 223–255.
- Fankhauser, S., Tol, R.S.J., Pearce, D.W., 1998. Extensions and alternatives to climate change impact valuation: on the critique of IPCC Working Group III’s impact estimates. *Environment and Development Economics* 3, 59–81.
- Fischer, G., Froberg, K., Parry, M.L., Rosenzweig, C., 1994. Climate change and world food supply, demand and trade: who benefits, who loses? *Global Environmental Change* 4 (1), 7–23.
- Folke, C., 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16 (3), 253–267.
- Geertz, C., 1973. Thick description: toward an interpretive theory of culture. In: *The Interpretation of Cultures: Selected Essays*. Basic Books, New York, pp. 3–30.
- Greenough, B., 2007. Situated knowledges and the spaces of consent. *Geoforum* 38, 1140–1151.
- Grundmann, R., 2007. Climate change and knowledge politics. *Environmental Politics* 16 (3), 414–432.
- Hansen, J., Johnson, D., Lacis, A., Lebedeff, S., Lee, P., Rind, D., Russell, G., 1981. Climate impact of increasing atmospheric carbon dioxide. *Science* 213, 957–966.
- Hoekstra, A.Y., Hung, P.Q., 2005. Globalisation of water resources: international virtual water flows in relation to crop trade. *Global Environmental Change* 15 (1), 45–56.
- Hornberg, A., McNeill, J.R., Martinez-Alter, J. (Eds.), 2007. *Rethinking Environmental History: World-System History and Global Environmental Change*. AltaMira Press, 420 pp.
- Hulme, M., 2010. *Cosmopolitan climates: hybridity, foresight and meaning*. *Theory, Culture and Society* 27 (2/3), 267–276.
- Hulme, M., Mahony, M., 2010. Climate change: what do we know about the IPCC? *Progress in Physical Geography*, doi:10.1177/0309133310373719.
- Jasanoff, S., 2005. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton University Press, Princeton & Oxford, 374 pp.
- Jasanoff, S., 2010. A new climate for society. *Theory, Culture & Society* 27 (2/3), 233–253.
- Jones, P.D., Wigley, T.M.L., Wright, P.D., 1986. Global temperature variations, 1861–1984. *Nature* 322, 430–434.
- Jordan, A., O’Riordan, T., 2004. Institutions for global environmental change. *Global Environmental Change* 14 (4), 367.
- Kandlikar, M., Sagar, A., 1999. Climate change research and analysis in India: an integrated assessment of a South–North divide. *Global Environmental Change* 9, 119–138.
- Karlsson, S., Srebotnjak, T., Gonzales, P., 2007. Understanding the North–South knowledge divide and its implications for policy: a quantitative analysis of the generation of scientific knowledge in the environmental sciences. *Environmental Science and Policy* 10, 668–684.
- Lahsen, M., 2004. Transnational locals: Brazilian experiences of the climate regime. In: Jasanoff, S., Martello, M.L. (Eds.), *Earthly Politics: Local and Global in Environmental Governance*. MIT Press, Cambridge MA, 366 pp., pp. 151–172.
- Lahsen, M., 2007. Trust through participation? Problems of knowledge in climate decision-making. In: Pettenger, M.E. (Ed.), *The Social Construction of Climate Change: Power, Knowledge, Norms, Discourses*. Ashgate Publishing Limited, Aldershot, UK, pp. 173–196.
- Leemans, R., 2008. Personal experiences with the governance of the policy-relevant IPCC and Millennium Ecosystem Assessments. *Global Environmental Change* 18 (1), 12–17.
- Livingstone, D.N., 2005. Text, talk and testimony: geographical reflections on scientific habits. An Afterword. *British Journal for the History of Science* 38 (1), 93–100.
- Lynas, M., 2007. *Six degrees: Our Future on a Hotter Planet*. Fourth Estate, 384 pp.
- Mayer, M., Arndt, F.J., 2009. The politics of siconatures: images of environmental foreign policy. In: Harris, P.G. (Ed.), *Environmental Change and Foreign Policy: Theory and Practice*. Routledge, London (Chapter 5).
- Miller, C.A., 2004. Climate science and the making of a global political order. In: Jasanoff, S. (Ed.), *States of Knowledge: The Co-production of Science and the Social Order*. Routledge, London, 317 pp., pp. 46–66.
- Miller, C.A., 2007. Democratization, international knowledge institutions and global governance. *Governance* 20 (2), 325–357.
- Neumayer, E., 2007. A missed opportunity: the Stern Review on climate change fails to tackle the issue of non-substitutable loss of natural capital. *Global Environmental Change* 17, 297–301.
- Ophir, A., Shapin, S., 1991. The place of knowledge: a methodological survey. *Science in Context* 4 (1), 3–21.
- Ostrom, E., 2010. Polycentric systems for coping with collective action and global environmental change. *Global Environmental Change* 20, 550–557.
- Parikh, J.K., 1992. IPCC strategies unfair to the South. *Nature* 360, 507–508.
- PBL, 2010. *Assessing an IPCC Assessment: An Analysis of Statements on Projected Regional Impacts in the 2007 Report*. PBL, The Hague/Bilthoven, Netherlands, 100 pp.
- Powell, R.C., 2007. Geographies of science: histories, localities, practises, futures. *Progress in Human Geography* 31 (3), 309–329.
- Price, M.F., 1990. Humankind in the biosphere: the evolution of international interdisciplinary research. *Global Environmental Change* 1 (1), 3–13.
- Radcliffe, S.A., Watson, E.E., Simmons, I., Fernandez-Armejo, F., Sluyter, A., 2010. Environmentalist thinking and/in geography. *Progress in Human Geography* 34 (1), 98–116.
- Randalls, S., 2010. History of the 2C climate target. *WIREs Climate Change* 1 (4), 598–605.
- Rockström, J., et al., 2009. A safe operating space for humanity. *Nature* 461, 472–474.
- Royal Society, 2009. *Geoengineering the Climate: Science, Governance and Uncertainty*. Royal Society Report, London, 82 pp.
- Sarewitz, D., 2010. Brick by brick. *Nature* 465, 29.
- Schiermeier, Q., 2010. IPCC flooded by criticism. *Nature* 463, 596–597.
- Scott, J.C., 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed*. Yale University Press, New Haven, 445 pp.
- Shapin, S., 1998. Placing the view from nowhere: historical and sociological problems in the location of science. *Transactions of the Institute of British Geographers* 23, 5–12.
- Stern Review, 2007. *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge, UK, 692 pp.
- Stern, T., Persson, U.M., 2008. An even Stern Review: introducing relative prices into the discounting debate. *Review of Environmental Economics and Policy* 2, 61–76.
- Stott, P.A., Thorne, P.W., 2010. How best to log local temperatures? *Nature* 465, 158–159.
- Szszynzki, B., Urry, J., 2010. Changing climates: introduction. *Theory, Culture & Society* 27 (2–3), 1–8.
- Tol, R.S.J., 2007. Europe’s long-term policy goal: a critical evaluation. *Energy Policy* 35, 424–432.
- Turner II, B.L., Kasperson, R.E., Meyer, W.B., Dow, K.M., Golding, D., Kasperson, J.X., Mitchell, R.C., Ratick, S.J., 1990. Two types of environmental change: definitional and spatial-scale issues in their human dimensions. *Global Environmental Change* 1 (1), 14–22.
- Weichselgartner, J., Kasperson, R., 2010. Barriers in the science-policy-practice interface: toward a knowledge-action-system in global environmental change research. *Global Environmental Change* 20 (2), 266–277.
- Wigley, T.M.L., Raper, S.C.B., 1991. Detection of the enhanced greenhouse effect on climate. In: Jäger, J., Ferguson, H.L. (Eds.), *Climate Change: Science, Impacts and Policy*. Cambridge University Press, Cambridge, pp. 231–242.