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As frames collide: making sense of carbon accounting

Francisco Ascui *

University of Edinburgh Business School, University of Edinburgh, Edinburgh, UK, and

Heather Lovell

School of Geosciences, University of Edinburgh, Edinburgh, UK

Abstract

Purpose – The purpose of this paper is to make sense of the tensions and contradictions between different conceptions of the meaning of carbon accounting.

Design/methodology/approach – The paper draws on theories of framing to help explain the divergent understandings and practices currently encompassed by the term ‘carbon accounting’. The empirical core of the paper is based on a review of the literature and illustrated through examples of some of the contemporary problems in carbon accounting.

Findings – Tensions and contradictions in carbon accounting can be understood as the result of ‘collisions’ between at least five overlapping frames of reference, namely physical, political, market-enabling, financial and social/environmental modes of carbon accounting.

Practical implications – Unresolved tensions in carbon accounting can undermine confidence in climate science, policies, markets and reporting, thereby ultimately discouraging action to mitigate climate change. Understanding this problem can contribute to finding practical solutions.

Originality/value – The paper makes three distinct contributions to the emerging theoretical literature on carbon accounting. First, it provides a unique ‘unpacked’ definition of carbon accounting that attempts to represent the contemporary range of meanings encompassed by the term. Second, we demonstrate how social science ideas about framing can help explain why definitions and understandings of carbon accounting vary. Third, by making the interactions between different forms of carbon accounting explicit through the metaphor of colliding frames of reference, the origins of some of the contemporary intractable issues in carbon accounting can be better understood.

Keywords – carbon accounting, framing, commensuration, carbon markets, carbon disclosure, carbon, climate change

Paper type – research paper

1 Introduction

Carbon accounting clearly means different things to different people. To scientists, it is “the practice of making scientifically robust and verifiable measurements of GHG [greenhouse gas] emissions.” (Watson, 2009: 6). To political negotiators, it implies “the rules for comparing emissions and removals as reported with commitments” at a national level (IPCC, 2005: 265). To practitioners in the United Nations Clean Development Mechanism (CDM) market, it involves the measurement of *reductions* in emissions relative to a hypothetical baseline, and other processes associated with the subsequent creation of a new tradable commodity: a carbon credit (Ministry of the

* Corresponding author. Francisco Ascui can be contacted at francisco.ascui@ed.ac.uk

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Environment, Japan, 2009). To the International Accounting Standards Board (IASB), it concerns the accounting of tradable emission rights and obligations arising under emissions trading schemes (IASB, 2008). To the increasing numbers of companies reporting to the Carbon Disclosure Project (CDP), The Climate Registry or other similar schemes, it involves the measurement and disclosure of greenhouse gas emissions for which companies accept varying degrees of responsibility (Kolk *et al.*, 2008; PricewaterhouseCoopers, 2009; WBCSD and WRI, 2004; Defra, 2009b).

Carbon accounting in these different senses has become an essential 'enabler' of several of society's key responses to the problem of climate change, including national emission limitation commitments, corporate climate change performance targets and carbon markets. Yet its role and contribution is generally overlooked. Furthermore, the connections, overlaps and discontinuities between different forms of carbon accounting have not received sufficient critical attention: different manifestations of carbon accounting each tend to have their own institutions, normative practices and distinctive discourse, including academic literatures. This paper takes a holistic view of what carbon accounting means across disciplines and institutions in order to make sense of the differences by placing different forms of carbon accounting in their historical and social context.

We propose that the contemporary space of carbon accounting can be conceptualised as a collision between at least five major 'framing' processes, where the 'hot' new world of political commitments and carbon markets meets the comparatively 'cooler' bedrock of physical carbon accounting, financial accounting and social/environmental accounting. Our core argument is that to date these carbon accounting 'frames' or perspectives have operated in relative isolation, and a better understanding of the relationship between these five frames could aid the development of solutions to accounting-based problems which can otherwise hamper climate change mitigation efforts.

This account of the five frames forms the empirical core of the paper. We show that an extensive literature on physical carbon measurement pre-dates and influences the more technical literature on 'political' accounting of carbon in national inventories, which in turn influences subsequent 'market-enabling' carbon accounting. Only in recent years, as carbon markets have begun to have material impacts on company balance sheets, have financial accountants begun to address financial accounting of rights and obligations in those markets (IASB, 2008; Cook, 2009, Lovell, 2010). A largely separate literature critically examines issues around corporate carbon disclosure and reporting (see Kolk *et al.*, 2008), building on a much larger literature on social and environmental accounting. Thus far there is only a small (but valuable) amount of research directly assessing the politics and practices of carbon accounting from a broader perspective (see Bebbington and Larrinaga-González, 2008; Cook, 2009; MacKenzie, 2009). In general, debates over carbon accounting have been taking place *within* frames, with relatively few interconnections. Here, by bringing together and critically examining the different meanings of carbon accounting, we hope to demonstrate the advantages of a more holistic assessment.

The paper is structured as follows. First, we provide a proposed definition of carbon accounting, representing the contemporary range of meanings encompassed by the term, which we believe constitutes a useful framework within which various problematic accounting issues can be situated and clearly identified. Second, we review relevant

literature from a range of social science disciplines on the theme of framing as discursive practice. Third, we provide an account of the five distinctive framings of carbon accounting: physical, political, market-enabling, financial, and social/environmental carbon accounting. Within this, we provide examples of key tensions in different understandings of carbon accounting that illustrate the complexity of the issues under consideration. In conclusion, we underline the fact that unresolved issues in carbon accounting have material negative consequences, and thus an improved understanding of the underlying causes of friction may contribute to finding workable solutions to climate change.

2 Defining carbon accounting

It is evident from the discussion so far that providing a neat, concise definition of carbon accounting is somewhat elusive and problematic; this in fact is the point of our paper. To begin with, 'carbon' is a term that can be used to mean several different things on its own: by scientists in a strict sense to refer to elemental carbon; more popularly to refer either to the principal greenhouse gas, carbon dioxide, alone, or as shorthand for all greenhouse gases (see Bebbington and Larrinaga-González, 2008: 714, note 1). When combined with 'accounting' and viewed through different frames of reference, the range of possible meanings is multiplied.

We believe it is useful to understand carbon accounting through the analogy of a jumbled landscape created by the collisions within and between multiple frames, rather than as a neatly delineated, essentialised object of inquiry (Callon, 1998; Lohmann, 2009). Nevertheless, it is also helpful to have a summary of the spectrum of activities that carbon accounting can involve across the different frames of reference. Accordingly, we propose that carbon accounting can be understood as the:

estimation calculation measurement monitoring reporting validation verification auditing	of	carbon carbon dioxide greenhouse gas	emissions to the atmosphere removals from the atmosphere emission rights emission obligations emission reductions legal or financial instruments linked to the above trades/transactions of any of the above impacts on climate change impacts from climate change	at	global national sub-national regional civic organisational corporate project installation event product supply chain	level, for	mandatory voluntary	research compliance reporting disclosure benchmarking auditing information marketing or other	purpose
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By selecting and combining different terms within this table, a multitude of more specific interpretations of carbon accounting may be derived. Thus, for example, climate scientists are chiefly concerned with *estimation* or direct *measurement* of *greenhouse gas emissions* and *removals* at the *global* level, for *research* purposes. The Climate Disclosure Standards Board, on the other hand, is interested in *reporting* of *greenhouse gas emissions* and *impacts from climate change* at the *corporate* level, for *voluntary disclosure* purposes (Climate Disclosure Standards Board, 2009). Specific definitions, then, are like pathways through the landscape created by the collisions between different frames.

Problematic issues may also be located within this landscape: for example, a 'walk' through *auditing of trades in financial instruments* linked to *carbon dioxide emission rights* at the *corporate* level for *mandatory compliance* purposes in the European Union

(EU) might encounter the recent issue of EU Allowance (EUA) VAT carousel fraud, thought to have resulted in multi-billion euro tax revenue losses and to have accounted for up to 13% of all EUA trades in the first half of 2009 (Ainsworth, 2010; New Energy Finance, 2010). Similarly, a range of contentious issues to do with offsetting and carbon neutrality can be found at the intersection of several other pathways, including those leading through *auditing of project-level emission reductions* (on the production side) and *corporate-level voluntary reporting for marketing-related purposes* (on the consumption side) (see for example Wara, 2008; Lovell, Bulkeley and Liverman, 2009). These and many other issues can be located within our deliberately broad definition of carbon accounting, and we return to several of them in section 4 below.

3 The politics of framing

We believe that the concept of framing helps us understand why such different conceptions of carbon accounting have developed, why certain issues are hotly contested (whereas others are not), and why carbon accounting practices frequently fall short of expectations. This is not a matter of merely theoretical interest: we believe that acknowledging and understanding these different framings can lead to more effective carbon accounting, and thus to more effective societal responses to the challenges posed by climate change.

At the most fundamental level, notions of carbon accounting involve the construction of meaning through discourse, defined by Hajer (1995: 44) as "...a specific ensemble of ideas, concepts and categorizations that are produced, reproduced and transformed in a particular set of practices and through which meaning is given to physical and social realities." The 'objects' of carbon accounting must be created through discursive acts which are fundamentally political in nature (Dryzek, 1997; Flyvbjerg, 1998; Hajer, 1995). As such, it is not surprising that the issue is characterised by continued uncertainty and ambiguity about both the nature of the problem and its solutions, much like other contentious environmental issues such as depletion of the ozone layer or acid rain (Hajer, 1995; Litfin, 1994).

Within the vast field of discourse analysis (see Fischer and Forester, 1993 for an overview) we concentrate on the concept of framing. Distinct literatures in public policy analysis (political science) and economic sociology use the concept of framing (see for example Rein and Schon, 1993; Callon, 1998; Hoffman and Ventresca, 1999; Laws and Rein, 2003; Lovell, 2004; Lohmann, 2005; Callon and Muniesa, 2007; Callon, 2009). In the policy discourse literature, frames are seen as a lens on the way that policy problems are viewed, discussed and resolved: "...a way of selecting, organising, interpreting and making sense of a complex reality to provide guideposts for knowing, analysing, persuading and acting. A frame is a perspective from which an amorphous, ill-defined, problematic situation can be made sense of and acted on." (Rein and Schon, 1993: 146). Similarly, for Callon and others in their analysis of markets, frames allow market agents to calculate and make sense of a market by drawing boundaries around it (Callon, 1998). In both literatures, by setting boundaries around an issue, frames act as a vital precursor to further action (Hajer, 1995; Kingdon, 1995; Rein and Schon, 1993). This is of course particularly relevant in situations where new policy problems (such as climate change) arise, where there is high uncertainty about how to respond. Framing defines the problem (and therefore also its solutions) by structuring the terms of the debate, foregrounding certain forms of knowledge, expertise and practice as relevant, and

setting limits on what action is judged to be appropriate. Framing is used to make sense of the world, and then actively affects our response.

One function of these discursive boundaries is to make sense of an amorphous reality; another is to claim ownership. Particular groups of people involved in the policy process frame an issue in ways that make it understandable and solvable to them – fitting their beliefs, values, knowledge and professional expertise (Power, 1991; 1997). This can lead to a struggle for ownership with other communities that have come together to frame the issue in their own way: for Hajer and others (Hajer and Versteeg, 2005; Hajer, 1995; Litfin, 1994; Lovell, 2004; Lovell *et al.*, 2009b) it is precisely this competition between discourses that drives policy change, therefore making it a valuable field of study.

A third feature of framing is that it is inevitably incomplete. As Callon (2009: 7) observes specifically in relation to carbon markets:

“At the heart of markets we find debates, issues, feelings, matters of concern, dissatisfaction, regrets, and plans to alter existing rules, which cannot be internalized once and for all because they are linked to irreducible uncertainties, to what I have called framings which are never either definitive or unquestionable. This ‘hot’ component of markets... always exists.”

While Callon and others concentrate on the ways in which frames deconstruct themselves via ‘entanglements’ and ‘overflows’ (Callon, 1998; Lohmann, 2009), we feel there is another level of interaction also taking place here, which we characterise as ‘collisions’ between different frames (Lovell and Smith, 2010). In recognising the interactions between separate frames we build upon Rein and Schon’s (1993) distinction between policy disagreements and policy controversies: disagreements occur within the same frame, controversies are between different frames, and thus are much more difficult to resolve.

Finally, a notable feature of frames is that, much like systems of measurement, classification and commensuration more generally (Espeland and Stevens, 1998; Bowker and Star, 2000; Alonso and Starr, 1984; Robson, 1992; MacKenzie, 2006; Latour, 1999), they are seldom acknowledged and often invisible to those using them:

“Although frames exert a powerful influence on what we see and neglect, and how we interpret what we see, they are, paradoxically, difficult to assess. Because they are part of the natural, taken-for-granted world, we are often unaware of their role in organising our preconceptions, thoughts and actions.” (Rein and Schon, 1993: 151).

By explicitly acknowledging and highlighting the framing of carbon accounting by different communities of practice, we believe there are significant opportunities to encourage constructive learning and policy change (what Rein and Schon term ‘frame-reflective discourse’; see Etzion and Ferraro, 2010 for an example) – a point we return to in our conclusions.

4 The multiple frames of carbon accounting

Over time, a range of actors and disciplines have attempted to measure ‘carbon’ and its impacts in various ways, for a number of different reasons. We identify five major framings of carbon accounting, involving actors as diverse as scientists, politicians, economists, accountants and activists. We will show that three of these – physical,

political and market-enabling carbon accounting – are closely related to one another, developing in sequence and each relying on the earlier frame. The fourth, financial carbon accounting, also follows in roughly temporal sequence as a consequence of market-enabling carbon accounting, but has very different origins and objectives, and is largely blind to the earlier frames. By contrast, the fifth frame of social/environmental carbon accounting has a longer pedigree which runs alongside the other frames, sometimes interacting, but with its own specific origins and objectives.

These five frames are not exclusive of other framings, and no doubt each can be critiqued from a variety of further perspectives. Nor can we hope to provide an exhaustive summary of the literature in relation to any individual frame. Rather, we aim to provide sufficient evidence to demonstrate that such framings exist, and to point to some of the key institutions, actors and social context which make up each of the identified frames.

4.1 Physical carbon accounting

The first of our frames can be characterised as the natural sciences view of carbon accounting as a matter of physical measurement, estimation or calculation and attribution of greenhouse gas fluxes through the biophysical environment. It has a long history: the first quantitative account of the global carbon cycle, including an estimate of the human-induced contribution from combustion of fossil fuels, was given by the Swedish geologist Arvid Högbom in 1895, and later used by his chemist colleague Svante Arrhenius to postulate the theory that the latter activity could cause long-term warming of the global climate, in a seminal 1896 paper (Högbom, 1895; Arrhenius, 1896; Rodhe, Charlson and Crawford, 1997). Although Arrhenius was only aware of two greenhouse gases at the time (carbon dioxide and water vapour) his estimate of the potential warming associated with a doubling of greenhouse gas concentrations in the atmosphere (5.7°C) was surprisingly close to modern-day estimates (Arrhenius, 1896; c.f. IPCC, 2007a). However, he believed that such an outcome would not eventuate for many thousands of years, based on Högbom's data on contemporary emission rates. As long as the *implications* of carbon accounting were believed to be benign or at worst remote, it remained a topic primarily of interest to geologists and atmospheric chemists seeking to understand natural processes such as the causes of past ice ages.

However, by the 1960s, increasingly accurate instrumental measurements of atmospheric carbon dioxide levels being made at the Mauna Loa observatory confirmed that concentrations were indeed higher than pre-industrial levels, and rising (Pales and Keeling, 1965). By the 1980s, scientific concern about human-induced global warming had well and truly 'overflowed' the purely scientific frame to become a subject of intense political and economic debate. This debate took place at multiple levels, the most significant of which was the United Nations General Assembly, where a number of resolutions led eventually to UN General Assembly Resolution 45/212 in 1990, which initiated negotiations that concluded in the adoption of the UN Framework Convention on Climate Change (UNFCCC) at the Rio Earth Summit in 1992.¹ This can be seen as the founding moment for our second frame of reference, political carbon accounting.

Physical carbon accounting of course continues to be the primary frame of reference on carbon accounting for thousands of climate scientists worldwide (for a broad synthesis of the literature see Chapter 2 in IPCC, 2007b). Nevertheless, it is increasingly difficult, if not impossible, to maintain separation between the science and the politics of climate change, as recently demonstrated by the furore generated over leaked emails from the

University of East Anglia's Climatic Research Unit (CRU) in the lead-up to the Copenhagen climate change summit in late 2009 (Biello, 2010).

With the exception of financial carbon accounting, all of the other framings look to physical carbon accounting for fundamental principles. Tensions and inconsistencies arise for two main reasons. First, non-scientists can be frustrated by the inability of science to give definitive answers in certain areas, such as the magnitude of non-carbon dioxide impacts from air travel, which has led to wide divergence in estimates of air travel offset requirements (see Padgett *et al.*, 2008; Defra, 2009a). Second, the provisional, evolving nature of the science poses a challenge for other forms of carbon accounting which seek to arrive at final conclusions with fixed consequences, several examples of which we provide in discussion of the other framings of carbon accounting.

4.2 Political carbon accounting

The new political framing of climate change represented by the UNFCCC required a corresponding re-framing of physical carbon accounting to suit an array of new objectives, including the attribution of “common but differentiated responsibilities” (UNFCCC Article 3.1) – words entailing significant economic consequences. The Intergovernmental Panel on Climate Change (IPCC), which was established in 1988 as the scientific and technical advisory body to the ongoing climate negotiations, played a key role in this re-framing process (Fogel, 2005). The IPCC is a classic example of a “boundary organization” that links and mediates between scientific and policy institutions and actors (Jasanoff, Markle *et al.*, 1995; Guston, 2000). In fact it produces explicitly “hybrid” knowledge that is neither purely scientific nor purely political, but both: the major IPCC reports comprise both a summary of the scientific literature prepared by a committee of scientists, and a summary for policy-makers which is only finalised in the highly charged political arena of a UNFCCC plenary to which all states are invited (Miller, 2001; Fogel, 2005).

The UNFCCC made carbon accounting at the national level mandatory for all signatories (“Parties”). Article 4.1 (a) requires all Parties to “Develop, periodically update, publish and make available... national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of Parties...” (United Nations, 1992). The IPCC was charged with developing the necessary “comparable methodologies”. The first *IPCC Guidelines for National Greenhouse Gas Inventories* were duly produced in 1995, and soon replaced by the *Revised 1996 Guidelines for National Greenhouse Gas Inventories* (IPCC, 1996). Use of the Revised 1996 Guidelines was subsequently mandated for national carbon accounting under both the UNFCCC and its subsidiary instrument, the Kyoto Protocol, in 1997.²

As Miller (2001: 489) observes:

“Measures of national emissions of greenhouse gases have become the accepted means within the climate regime for assigning blame for changes in the climate and therefore for assigning responsibility for undertaking action to help stabilize the atmosphere. Such measures thus have enormously high political significance within the regime...”

The role of boundary organisations such as the IPCC is to come up with both the normative and technical judgements required to produce standardised and politically acceptable carbon accounting rules, methodologies and procedures (Miller, 2001). Thus the political framing of carbon accounting takes a step away from the scientific mode of measurement, calculation and estimation of greenhouse gas emissions at the global level, towards a function of monitoring and reporting at the national level. Political expediency dictates the scope of national inventories: emissions which cannot be attributed to human activities, emissions of greenhouse gases already controlled by the Montreal Protocol, and emissions associated with international air and maritime transport are all excluded (IPCC, 1996). The need for standardised methodologies to enable comparisons between countries and over time creates the potential for conflict with the provisional and ever-evolving nature of the science.

An apt illustration of such a conflict concerns the use of conversion factors to evaluate the net impact of different greenhouse gases (GHGs), each with their own unique atmospheric chemistry and contribution to global warming (Mackenzie, 2009; IPCC, 2007b; Plattner *et al.*, 2009). Climate scientists have formulated various ways of measuring and commensurating the climate impacts of different GHGs, the most influential of these being Lashof and Ahuja (1990), who developed the theoretical framework for what is now known as 'global warming potential' (GWP) – a metric of the contribution to global warming of a given mass of GHG over a given time horizon, all conveniently expressed in multiples of carbon dioxide equivalent.

The driver for development of this index was both political and economic: as Lashof and Ahuja note, "An index to compare the contribution of various 'greenhouse' gas emissions to global warming is needed to develop cost-effective strategies for limiting this warming." (1990: 529). In addition to being only one of several possible approaches (for others see Plattner *et al.*, 2009) the approach is beset with uncertainties, both empirical (e.g. uncertainty in observations of atmospheric residence times) and theoretical (e.g. results being sensitive to the choice of time horizon). However, in 1997, Article 5.3 of the Kyoto Protocol mandated the use of an arbitrary set of global warming potentials (those published in 1996 by the IPCC in its Second Assessment Report) for the purposes of national carbon accounting over the first commitment period (2008-2012).

This political choice has given rise to divergences between physical and political carbon accounting. Estimates of the GWP of various GHGs published in the scientific literature, and summarised by the IPCC in subsequent assessment reports, continue to be revised, whereas the factors now used in reporting under the UNFCCC and Kyoto Protocol – and in a wide range of national and corporate reporting standards developed since then – have remained static (UNFCCC, 2006; 2008). The UK's national emissions, for example, are calculated using the 1996 GWP 'exchange rate' for methane of 21 times the equivalent mass of carbon dioxide, whereas the latest IPCC assessment report suggests that a value of 25 times is more accurate – a variation of nearly 20% (Defra, 2006; IPCC, 2007b: 212). If measured over a 20-year time horizon rather than the conventional 100 years, the latest GWP of methane rises to 72 (IPCC, 2007b). These alternatives have major implications for where governments should direct their climate mitigation efforts, yet the political decisions are fundamentally arbitrary from a scientific perspective. As

Milne *et al.* put it, after reviewing the wild fluctuations in estimates of New Zealand's national inventory from 2005 to 2009: "GHG emission accounting, like much other accounting, is set to remain part science, part modelling, part guesswork and part negotiation" (2010: 27).

4.3 Market-enabling carbon accounting

In the 1990s, relying in part on the use of global warming potentials to enable the commensuration of different GHGs emitted in different places at different times, economists such as Nordhaus began to frame climate change as essentially an optimal control problem, the ideal policy solution to which would lie at the point where marginal abatement costs would equal the marginal damages caused by climate change (1991: 924). From here it was a small – yet momentous – step to postulate that a *market* for abatement of greenhouse gases would be more likely to arrive at this optimal solution than even the most well-meant policy-making. The USA had experimented with a market approach to regulating sulphur dioxide emissions since the early 1990s, with great apparent success, in terms of breaking the policy-making impasse, reducing emissions at lower than expected cost, and fostering innovation (Wambsganss and Sanford, 1996; Johnston *et al.*, 2008; MacKenzie, 2009). Largely at the insistence of the United States, the individual caps on developed countries' greenhouse gas emissions in the Kyoto Protocol were linked by the three 'flexibility mechanisms' of International Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM), together creating a framework for a global market in greenhouse gas emission rights, driven by emission obligations (United Nations, 1998).

Discrepancies immediately arose between the *political* carbon accounting of the UNFCCC and the *market-enabling* carbon accounting of the Kyoto Protocol. Creating the demand and supply necessary for a market in something as intangible as GHG emission rights and obligations implies numerous acts of quantification, measurement and commensuration (Espeland and Stevens, 1998; Lohmann, 2005; Mackenzie, 2009; Lohmann, 2009). On the one hand, demand was created by placing caps on national emissions from developed countries, which naturally looked to existing IPCC methodologies developed for the purposes of measuring national emissions in a consistent manner, as discussed above. On the other hand, supply was created in two different ways: firstly, by creating emission rights and enabling trading between capped countries facing different costs of compliance, and secondly, by creating an entirely new, fictitious commodity in the form of an emission right based on an *emission reduction* achieved in a country without a cap (this being the function of the Clean Development Mechanism).

Under the UNFCCC, developing countries have an obligation to account for their national emissions, but without any associated or implied responsibility (under the principle of "common but differentiated responsibilities"). With the introduction of the Kyoto Protocol's CDM, entirely new carbon accounting rules were required to enable the measurement of *emission reductions against a hypothetical baseline* within defined *projects*, whereas previous accounting rules concerned the measurement of *emissions* and *removals* taking place within *national* boundaries. Such emission reductions give rise to credits known as Certified Emission Reductions (CERs); a developed country may

obtain such CERs and use them to exceed its cap by one tonne of carbon dioxide (or its equivalent in other GHGs) per CER.

Thus the CDM is engaged in an entirely novel project of ‘making things the same’ (MacKenzie, 2009): in this case, making reductions in emissions against a baseline equivalent to emission rights in developed countries. The Kyoto Protocol created a mandate for this but did not specify how it would work; more detailed rules were not agreed at the political level until 2001 and the practical framework continues to evolve, with the full ‘rulebook’ now running to over 1,000 pages.³ Methodologies for measuring emission reductions against a hypothetical baseline simply did not exist and had to be invented – significantly, in this case not by scientists or politicians, but by a range of non-state, largely private sector actors involved in CDM project development, via a bottom-up process of methodology proposal, review and rejection or acceptance by the CDM Executive Board (for a discussion of some of the non-state actors involved, see Lovell, Bulkeley and Liverman, 2009). There are now literally hundreds of CDM methodologies available for different types of project.⁴ The process has been criticised for failing to take the necessary political decisions to resolve contentious issues, and for producing outcomes riddled with inconsistencies (Michaelowa *et al.*, 2007).

One of the most contentious areas of carbon accounting over the past two decades has been the treatment of stored carbon, known in UNFCCC parlance as ‘sinks’. Examples of sinks include carbon stored in forests (Watson, 2009), forest products (Lim *et al.*, 1999), soils (Shackley and Sohi, 2010), or deep underground, for example through carbon capture and geological storage (CCS) (IPCC, 2005; Grönkvist *et al.*, 2006). Negotiators of the Kyoto Protocol in 1997 were unable to decide whether to allow the CDM to provide carbon credits to projects that reduce deforestation, thereby maintaining forest carbon sinks that would otherwise be lost. The IPCC was commissioned to prepare a Special Report on Land Use, Land Use Change and Forestry (LULUCF), which highlighted the many technical difficulties associated with measuring reductions in deforestation, although not without considerable dispute between participants: one observer relates the stories of numerous “boundary battles” taking place within the IPCC Special Report plenary over the issue (Fogel, 2005: 200). When more detailed rules on the CDM were finally agreed in Marrakesh in 2001, eligible activities in the LULUCF sector were limited to afforestation and reforestation, excluding reduced deforestation. Nine years later, reduced deforestation is still excluded from carbon markets under the Kyoto Protocol, although it is on the agenda for a post-2012 climate agreement, under the new guise of ‘REDD’ (Reducing Emissions from Deforestation and forest Degradation).⁵ Reduced deforestation remains a hotly contested area in market-enabling carbon accounting; one where the collisions between the scientific, political and market-enabling frames have not yet been resolved, particularly in relation to issues such as accounting for the non-permanence of forest carbon stocks (Neeff and Ascui, 2009; Eliasch, 2008).

4.4 Financial carbon accounting

The Kyoto Protocol created new GHG emission rights and obligations on states, not corporations. In many jurisdictions, however, states have created mirroring rights and obligations on corporations, particularly the owners or operators of large point sources of emissions such as power stations and industrial facilities, through the implementation

of national or regional emissions trading schemes. Most notable of these has been the European Union Emissions Trading Scheme (EU ETS), to date still the largest carbon market in the world, with transaction volumes reaching \$118 billion in 2009 (Kossoy and Ambrosi, 2010; New Energy Finance, 2010). Companies operating in these carbon markets have new liabilities, assets and financial flows to account for in their financial reports. However, doing so has proven difficult, due to conflicts which we believe can be characterised as the collision between a new attempt at framing carbon in terms of existing financial accounting concepts, and the incumbent framing in already-existing carbon markets.

The International Accounting Standards Board (IASB) requested its International Financial Reporting Interpretations Committee (IFRIC) to provide guidance on the accounting treatment of *emission rights* and *obligations*, which was duly issued by the IASB in December 2004 as *IFRIC Interpretation 3: Emission Rights* (IFRIC-3), just before the 1 January 2005 start of the first phase of the EU ETS. However, the guidance was withdrawn in June 2005 after concerns were raised about various inconsistencies, only six months after it had been issued (Cook, 2009). Since the withdrawal of IFRIC-3, there has been no international guidance on how to account for EU ETS rights and obligations and a diversity of accounting practices has emerged (PricewaterhouseCoopers and IETA, 2007; Cook, 2009; MacKenzie, 2009; McGready, 2008). The issues raised in relation to accounting for emission allowances or permits, particularly when they are gifted by the state, echo an earlier debate over financial accounting of sulphur dioxide permits in the USA (see Wambsganss and Sanford, 1996; critiqued in Milne, 1996; see also Grinnell and Hunt, 2002). However, a crucial difference now is that carbon trading schemes are multi-national in scope, implying a need for global convergence on financial carbon accounting, which was not necessary for the case of sulphur dioxide permits.

Thus far, however, progress towards a global standard for financial carbon accounting has been slow. In 2008, the Emissions Trading Schemes project was re-launched by the International Accounting Standards Board (IASB) in conjunction with the US Financial Accounting Standards Board (FASB) (IASB 2008). The IASB's new work on carbon accounting addresses the accounting of all tradable emissions rights and obligations arising under emissions trading schemes, as well as the accounting of activities undertaken in contemplation of receiving tradable rights in future periods, e.g. Certified Emission Reductions (CERs) under the CDM. It is evident that carbon sits between and challenges a number of existing financial accounting standards, including IAS 20 (government grants), IAS 38 (intangible assets) and IAS 39 (financial instruments), and steps are currently being taken to resolve this ambiguous situation, principally by the IASB/FASB as well as individual accountancy firms (see KPMG, 2008). Scholars have interpreted this ambiguity in accounting rules as illustrative of a more fundamental lack of consensus about the accounting treatment of carbon (Cook, 2009; MacKenzie, 2009).

Carbon has been difficult to classify in part because accountants and accounting standard-setters lack a full appreciation of the 'production process' of carbon credits: the science, politics and market-enabling rules involved in turning greenhouse gas emissions, and emission reductions, into tradable commodities (Lovell, 2010). A lack of knowledge and experience can be expected to reduce over time, but a more fundamental challenge is the way in which types of knowledge and information are framed by accountants as

relevant to their decision making. Accountants typically seek to understand carbon by comparison with existing, more familiar, accounting entities such as taxes, leases, subsidies and commodities, without appreciating the complexities caused by changes in climate policy or regulation, such as the shift to increased auctioning of carbon allowances from 2013 in the EU ETS, which to date has not received significant coverage in technical IASB-FASB Board discussions, despite its importance (ibid). When project managers on the IASB-FASB emissions trading scheme project were interviewed about the reasons for the delay in publication of an Exposure Draft (from 2009 to 2010 – see IASB, 2008), it became clear that, in their view, it was not related to key political developments such as the outcomes of the Copenhagen climate change summit in December 2009 or uncertainty about the launch of a US-wide emission trading scheme (Lovell, 2010). Indeed, their puzzled response to this line of questioning made it apparent that these climate change policy issues were outside their frame of reference.⁶ We predict that financial accounting for carbon will remain contentious for many years to come, due to these fundamental conflicts between frames.

4.5 Social/environmental carbon accounting

The last of our five frames emerges from the broader context of social and environmental accounting, which has developed as a rich and diverse arena for practice and research over the past four decades (see Mathews, 1997; Gray *et al.*, 1993; Unerman *et al.*, 2007; Gray, 2002; Parker, 2005; Owen, 2008). It is clear from these reviews that social and environmental accounting, like carbon accounting, means different things to different people. Indeed, there are close parallels between what we observe in carbon accounting today and an early description by Mathews of the social accounting field:

“...the extension of social accounting measurements and disclosures is affected by confusion, measurement problems and disagreements about the legitimacy of accounting activity in this field. The confusion arises because the term social accounting is used in different ways by different groups of people and the measurement difficulties are always present in any new area; indeed, they are what accounting is all about.” (1984: 200)

While there are many aspects of social/environmental reporting *practice* that have contributed to contemporary carbon accounting, Gray *et al.* (2007: 17) note “the almost complete absence” of carbon accounting in the social accounting literature (however, important contributions have been made since then, for example Bebbington and Larrinaga-González, 2008). We focus here on two traditions of particular interest: corporate sustainability reporting and product Life Cycle Analysis (LCA).

Corporate sustainability reporting has long been the most prominent area of practice and research in social and environmental accounting: termed “Social Responsibility Accounting” in Mathews’ early classification of the field and defined then as “Voluntary disclosure of information, both qualitative and quantitative, made by organisations to inform or influence a range of audiences” (Mathews, 1984: 204). Corporate sustainability reporting can be seen as an extension of traditional financial reporting to include social and environmental policies and impacts, influenced since the late 1990s by the notion of the ‘triple bottom line’ (Milne and Gray, 2007; Milne *et al.*, 2008; Milne *et al.*, 2009).

Energy use and greenhouse gas emission statistics appeared in some of the earliest of these sustainability reports and are now routinely included as core environmental indicators under the Global Reporting Initiative (GRI). However, they constitute only a handful of the dozens of GRI core indicators: in this tradition, climate change is only one amongst many social and environmental impacts.

Climate-change-specific corporate reporting can be seen as an extension from this. A significant 'enabler' was the development of the Greenhouse Gas Protocol corporate accounting and reporting standard by the World Resources Institute and the World Business Council for Sustainable Development (WBCSD and WRI, 2004). While based in part on IPCC guidelines (i.e. political carbon accounting), the GHG Protocol introduces entirely new concepts relevant only to corporate emissions, such as a division between three scopes of direct (Scope 1), electricity- and heat-related indirect (Scope 2) and other indirect (Scope 3) emissions (ibid). Since first publication in 2001, the GHG Protocol has been incorporated into dozens of voluntary and governmental reporting guidelines, including the GRI and an international standard (ISO14064-1). However, as noted by Kolk *et al.* (2008: 738), the appearance this gives of standardisation is misleading: many of the 'derived' guidelines modify or supplement the GHG Protocol in unique ways (see for example Defra, 2009b), leading to inconsistencies in global corporate reporting.

A second major development in climate-change-specific corporate reporting was the establishment of the Carbon Disclosure Project (CDP) in 2000. In 2002, backed by a group of 35 signatory investors with US\$4.5 trillion in assets, the CDP issued a call to FT500 Global Index companies for information relating to their *impacts on and from* climate change (Innovest, 2003). By 2009, the CDP was proudly acting "On behalf of 475 investors with assets of US \$55 trillion" (PricewaterhouseCoopers, 2009). Carbon disclosure appears to be going 'mainstream' even faster than its corporate sustainability 'parent': while the number of companies registering GRI reports reached 1,000 for the first time in 2008, the same milestone was reached in terms of companies responding to the CDP in 2007, and by 2009, the number of CDP reports (2,456) was nearly double the GRI level.⁷ The comparison may be a little unfair, because a CDP 'response' is not necessarily complete, nor necessarily made public; while the number of companies producing reports based on GRI guidance is undoubtedly much higher than the number registering these reports with GRI.⁸ Nevertheless, the growth in carbon disclosure, particularly since 2006 through the CDP, has been astounding. The resulting data provides a rich basis for research into the relationships between disclosure, management strategies and various measures of performance – even if a preliminary analysis by Kolk *et al.* suggests that "...in spite of increasing response rates and expanding volume of the answers, there is no real evidence that the information is helpful and is being used by investors in their decision-making processes" (2008: 741). It also provides a basis for emergent forms of carbon *benchmarking* (Mackenzie *et al.*, 2009; Czyz *et al.*, 2010).

Kolk *et al.* note a number of factors that have played a part in the rapid institutionalisation of carbon disclosure, including "the convergence of business, governments, NGOs and key academic and professional constituencies around a somewhat fragmented, decentralized and market-oriented mode of carbon governance"

(2008: 722) – namely, carbon trading. This convergence on carbon markets as a dominant paradigm has undoubtedly influenced corporate behaviour in different ways. In some constituencies, carbon accounting and reporting has been imposed on companies, for example under the EU ETS, where annual reporting of verified carbon dioxide emissions became mandatory for large emitters from 2005. In other constituencies, carbon accounting and voluntary reporting may be driven by anticipation of future carbon regulation. Other influences may be more subtle: the rapid expansion, particularly since 2006, in voluntary carbon offsetting is an area that would benefit from further research into corporate motivations, stakeholder influence and the role of the dominant regulatory discourse in shaping voluntary practice (see Hamilton *et al.*, 2010; Bumpus and Liverman 2008; Lovell *et al.*, 2009a; Deegan and Blomquist, 2006; Mackenzie and Ascui, 2009; Villiers and van Staden, 2006). Carbon accounting has also entered the discourse of strategy: measuring an organisation's 'carbon footprint' has become a widely accepted first step in developing a corporate climate change strategy (Hoffman, 2007; Lash and Wellington, 2007; PricewaterhouseCoopers, 2007).

The above discussion has focussed on organisations, particularly private sector corporations, as the main subjects of social/environmental carbon accounting. However, the notion of the 'carbon footprint' descends, in part at least, from the earlier, much broader, concept of 'ecological footprint' as a way of measuring and comparing the totality of environmental impacts (Rees, 1992; Wackernagel and Rees, 1996). The related concept of a product carbon footprint owes a great deal to the theory and methods of Life Cycle Analysis (LCA – for a recent review see Finnveden *et al.*, 2009). LCA has traditionally been dominated by scientists rather than accountants. Perhaps for this reason, we find a recent standard (heavily derived from LCA practices) known as PAS 2050 for carbon accounting of goods and services (BSI, 2008) specifying the use of the *latest* IPCC figures for global warming potentials – thus giving rise to discrepancies between, say, a company's emissions as reported under the EU Emissions Trading Scheme or the WRI/WBCSD GHG Protocol (which both follow the Kyoto Protocol approach of using 1996 IPCC values) and the emissions associated with the company's products. Other problems of comparability arise when a product footprint expressed as a carbon label, e.g. on Walker's crisps – is compared against the footprint of an alternative product (Carbon Trust, 2008). Like previously mentioned national and project-level carbon accounting, LCA and corporate reporting standards can be seen as attempts to define different boundaries and responsibilities for GHG emissions, with overlapping and contested results.

5 Conclusions

In summary, we wish to draw attention to the fact that carbon accounting is conceptually contested, policy relevant and a rich subject for research. Unacknowledged and unresolved tensions in carbon accounting can undermine confidence in climate science, policies, markets and reporting, thereby ultimately discouraging action to mitigate climate change: making sense of carbon accounting presents an opportunity to make a positive contribution to finding practical solutions.

We have shown that carbon accounting is *contested*, meaning many different things to different people. Drawing on social science theories of framing, we believe that carbon accounting can best be understood as a set of ongoing discursive acts, each setting boundaries, defining terms and claiming ownership of the issue, leading to what we have

characterised as a jumbled landscape created by the collision between five major frames of reference: physical, political, market-enabling, financial and social/environmental modes of carbon accounting. This enables us to provide an ‘unpacked’ definition of carbon accounting that sets out and makes explicit the different understandings that various groups have of the term (reflecting different origins and objectives, as we have shown through our review of each of the five frames).

We also hope to have shown that carbon accounting is *relevant*: it is precisely the easily overlooked systems of classification, measurement, commensuration and communication that underpin society’s key responses to the ‘super wicked problem’ (Lazarus, 2009) of climate change. When carbon accounting fails to provide adequately comparable information on corporate emissions, impacts and responses to enable investors to take appropriate decisions (Kolk *et al.*, 2008), fails to incentivise tropical countries to reduce deforestation (Eliasch, 2008; Neeff and Ascui, 2009), or prevents investment in biomass carbon capture and storage because it fails to recognise and reward negative emissions (Grönkvist *et al.*, 2006), society as a whole loses valuable opportunities to avoid or reduce the damage caused by climate change. We believe that making sense of carbon accounting and bringing knowledge and experience from different communities together provides significant potential for constructive learning and positive policy change.

An excellent example of how this could be done is the establishment by the Carbon Disclosure Project of the Climate Disclosure Standards Board (CDSB), bringing together several of the communities of practice associated with different carbon accounting frames: the Board includes stakeholders familiar with social/environmental and market-enabling carbon accounting,⁹ and the Technical Working Group comprises all of the ‘Big Four’ global accountancy firms and a number of accounting professional bodies, as well as climate scientists in an advisory role. The CDSB has released an Exposure Draft Reporting Framework, deliberately presented in a form compatible with a draft IASB standard and aimed at standardising disclosure of climate change policies and impacts in mainstream financial reports (Climate Disclosure Standards Board, 2009). Nevertheless, it appears there is still room for improvement, as accounting standard-setters are notably absent: the Exposure Draft states that “...the proposed Framework is not an IASB standard or exposure draft and neither the IASB nor its member bodies have been consulted on the positions taken in the proposed Framework” (Carbon Disclosure Standards Board, 2009: 4). It remains to be seen how this attempt to re-draw the boundaries of carbon accounting (and associated competencies in terms of who sets standards and who claims expertise in carbon accounting, auditing and verification) will develop. Further research into the process would be useful, perhaps building on earlier work by Power (1991; 1997) in relation to defining the boundaries and competencies of environmental audit.

Finally, we hope to have shown that carbon accounting is *interesting*: that it offers tremendous scope for further research. We believe that it is time to acknowledge carbon accounting as a new research agenda, worthy of investigation in itself (in the manner of Burchell *et al.*, 1980), as well as in its manifold practical applications. We make a plea for future research to be interdisciplinary and to acknowledge the multiple framings of carbon accounting, in order to contribute practical solutions that ultimately enhance the efficiency and effectiveness of society’s response to climate change.

¹ United Nations General Assembly Resolution 45/212 Protection of global climate for present and future generations of mankind. Available at <http://www.un.org/documents/ga/res/45/a45r212.htm> (accessed 10 September 2009).

² Decision 2/CP.3, available at unfccc.int/resource/docs/cop3/07a01.pdf (accessed 29 December 2009).

³ According to the legal firm Baker and Mackenzie, authors of the online rulebook available at <http://cdmrulebook.org/> (accessed 18 December 2009).

⁴ See <http://cdm.unfccc.int/methodologies/index.html> (accessed 8 January 2010).

⁵ See for example the Copenhagen Accord, available at http://unfccc.int/files/meetings/cop_15/application/pdf/cop15_cph_auv.pdf (accessed 8 January 2010).

⁶ Interview conducted as one of a set of 20 interviews with accountants as part of a Nuffield Foundation supported research project (see Lovell and Mackenzie, 2011).

⁷ See <http://www.globalreporting.org/AboutGRI/FactSheet.htm> and <https://www.cdproject.net/en-US/Results/Pages/overview.aspx> (accessed 24 September 2010).

⁸ See for example <http://www.corporateregister.com/>

⁹ The Climate Disclosure Standards Board includes, in addition to CDP, CERES (the organisation behind the GRI), The Climate Group, The Climate Registry, International Emissions Trading Association, World Economic Forum and World Resources Institute (Carbon Disclosure Standards Board, 2009).

References

- Ainsworth, R. T. (2010), "CO₂ MTIC fraud – technologically exploiting the EU VAT (again)", Boston University School of Law Working Paper No. 10-01 (January 7, 2010), available at: <http://www.bu.edu/law/faculty/scholarship/workingpapers/2010.html> (accessed 18 January 2010).
- Alonso, W. and P. Starr (1984), *The Politics of Numbers: the Population of the United States in the 1980s*, Russell Sage Foundation, New York, USA.
- Arrhenius, S. (1896), "On the influence of carbonic acid in the air upon the temperature of the ground", *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science* 41: 237-276.
- Bebbington, J. and Larrinaga-González, C. (2008), "Carbon trading: Accounting and reporting issues", *European Accounting Review* 17 (4): 697-717.
- Biello, D. (2010), "Negating "Climategate"", *Scientific American* 302 (2): 16.
- Bowker, G. C. and Star, S. L. (2000), *Sorting things out: classification and its consequences*, MIT Press, Cambridge, Mass.; London.
- British Standards Institution (BSI) (2008), *PAS 2050:2008. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*, British Standards Institution, London.
- Bumpus, A. G. and Liverman, D. M. (2008), "Accumulation by decarbonization and the governance of carbon offsets", *Economic Geography* 84 (2): 127-155.
- Burchell, S., Clubb, C., Hopwood, A., Hughes, J. and Nahapiet, J. (1980), "The roles of accounting in organizations and society", *Accounting, Organizations and Society* 5 (1): 5-27.
- Callon, M. (1998), "An essay on framing and overflowing: economic externalities revisited by sociology" in Callon, M., *The Laws of the Markets*, Blackwell Publishers/The Sociological Review, Oxford, pp. 244-269.
- Callon, M. (2009), "Civilizing markets: carbon trading between in vitro and in vivo experiments", *Accounting, Organizations and Society* 34 (3-4): 535-548.
- Callon, M. and Muniesa, F. (2007), "Economic experiments and the construction of markets. Do Economists Make Markets?" in MacKenzie, D., Muniesa, F. and Siu, L., (Eds.), *On the performativity of economics*, Princeton University Press, Princeton, NJ, USA, pp. 163-189.
- Carbon Trust (2008), *Product carbon footprinting: the new business opportunity. Experience from leading companies*, The Carbon Trust, London.
- Climate Disclosure Standards Board (2009), *The Climate Disclosure Standards Board (CDSB) Reporting Framework: Exposure Draft*, Carbon Disclosure Project, London.
- Cook, A. (2009) "Emission rights: From costless activity to market operations", *Accounting, Organizations and Society* 34 (3-4): 456-468.
- Czyz, K., Gozdowska, I., Mackenzie, C. and McMahon, S. (2010), *FTSE CDP Carbon Strategy Index Series: 350 Index Results Report 2010*, ENDS Carbon, London.
- Deegan, C., and Blomquist, C. (2006), "Stakeholder influence on corporate reporting: an exploration of the interaction between WWF-Australia and the Australian minerals industry", *Accounting, Organizations and Society* 31: 343-372.
- Department for Environment, Food and Rural Affairs (Defra) (2006), *The United Kingdom's Initial Report under the Kyoto Protocol*, Department for Environment, Food and Rural Affairs, London, available at http://unfccc.int/national_reports/initial_reports_under_the_kyoto_protocol/items/3765.php (accessed 18 September 2009).
- Department for Environment, Food and Rural Affairs (Defra) (2009a), *2009 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors*, Department for Environment, Food and Rural Affairs, London, available at

<http://www.defra.gov.uk/environment/business/reporting/pdf/091013-guidelines-ghg-conversion-factors-method-paper.pdf> (accessed 10 January 2010).

Department for Environment, Food and Rural Affairs (Defra) (2009b), *Guidance on how to measure and report your greenhouse gas emissions*, Department for Environment, Food and Rural Affairs, London.

Dryzek, J. (1997), *The Politics of the Earth: Environmental Discourses*, Oxford University Press, Oxford.

Eliasch, J. (2008), *Climate change: Financing global forests*, The Stationery Office, London.

Espeland, W. N. and Stevens, M. L. (1998), "Commensuration as a social process", *Annual Review of Sociology* 24: 313-143.

Etzion, D. and Ferraro, F. (2010), "The Role of Analogy in the Institutionalization of Sustainability Reporting", *Organization Science* 21 (5): 1092-1107.

Finnveden, G., Hauschild, M. Z., Ekvall, T., Guinée, J., Heijungs, R., Hellweg, S., Koehler, A., Pennington, D. and Suh, S. (2009), "Recent developments in Life Cycle Assessment", *Journal of Environmental Management* 91(1): 1-21.

Fischer, F. and Forester, J. (1993) *The Argumentative Turn in Policy Analysis and Planning*. UCL Press Ltd, London.

Flyvbjerg, B. (1998) *Rationality and Power: Democracy in Practice*. University of Chicago Press, Chicago.

Fogel, C. (2005), "Biotic carbon sequestration and the Kyoto Protocol: The construction of global knowledge by the Intergovernmental Panel on Climate Change", *International Environmental Agreements* 5: 191-210.

Gray, R. (2002) "The social accounting project and *Accounting Organizations and Society*: Privileging engagement, imaginings, new accountings and pragmatism over critique?", *Accounting, Organizations and Society* 27 (7): 687-708.

Gray, R., Bebbington, J. and Walters, D. (1993), *Accounting for the environment*, Paul Chapman in association with ACCA, the Chartered Association of Certified Accountants, London.

Gray, R., Dillard, J. and Spence, C. (2007), "(Social) accounting (research) as if the world matters: Postalgia and a new absurdism", paper presented at the Fifth Asia Pacific Interdisciplinary Research in Accounting Conference, 8-10 July 2007, Auckland, New Zealand, available at: <http://www.bsec.canterbury.ac.nz/apira2007/proceedings.html> (accessed 10 September 2009).

Grinnell, D., and Hunt, H. (2002), "Gifted pollution allowances: recognizing a liability to society", *Critical Perspectives on Accounting* 13 (2): 211-228.

Grönkvist, S., Möllersten, K. and Pingoud, K. (2006), "Equal opportunity for biomass in greenhouse gas accounting of CO₂ capture and storage: A step towards more cost-effective climate change mitigation regimes", *Mitigation and Adaptation Strategies for Global Change* 11: 1083-1096.

Guston, D. (2000), *Between politics and science: Assuring the integrity and productivity of research*, Cambridge University Press, Cambridge.

Hamilton, K., Sjardin, M., Peters-Stanley, M. and Marcello, T. (2010) *Building Bridges: State of the Voluntary Carbon Markets 2010*, Bloomberg New Energy Finance and Ecosystem Marketplace, New York, NY, USA and Washington, DC, USA.

Hajer, M. and Versteeg, W. (2005), "A Decade of Discourse Analysis of Environmental Politics: Achievements, Challenges, Perspectives", *Journal of Environmental Policy and Planning* 7 (3): 175-184.

Hajer, M. (1995), *The Politics of Environmental Discourse: Ecological Modernisation and the Policy Process*, Clarendon Press, Oxford.

Hoffman, A. J. (2007), *Carbon strategies: How leading companies are reducing their climate change footprint*, University of Michigan Press, Ann Arbor, MI, USA.

- Hoffman, A. J. and Ventresca, M. J. (1999), "The institutional framing of policy debates: economics versus the environment", *American Behavioural Scientist* 42(8): 1368-1392.
- Högbom, A. (1895), "Om sannolikheten for sekulara forändringar i atmosfärens kolsyrehalt", *Svensk kemisk tidskr* 5: 169-176.
- IASB (2008), "International Accounting Standards Board (IASB) - Information for Observers: Emissions Trading Schemes; Board meeting 20 May 2008", available at: <http://www.iasb.org/NR/rdonlyres/92B01EDC-E519-431F-915F-0F33505D7DFD/0/ETS0805b03obs.pdf> (accessed 3 October 2008).
- Innovest (2003), *Carbon Disclosure Project: Carbon finance and the global equity markets*, Carbon Disclosure Project, London.
- Intergovernmental Panel on Climate Change (IPCC) (1996), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Intergovernmental Panel on Climate Change, available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html> (accessed 10 April 2008).
- Intergovernmental Panel on Climate Change (IPCC) (2005), *IPCC Special Report on Carbon dioxide Capture and Storage*, available at: http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf (accessed 10 April 2008).
- Intergovernmental Panel on Climate Change (IPCC) (2007a), *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (Eds.)], Cambridge University Press, Cambridge and New York, NY, USA.
- Intergovernmental Panel on Climate Change (IPCC) (2007b), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.)], Cambridge University Press, Cambridge and New York, NY, USA.
- Jasanoff, S., Markle, G. E., Petersen, J. C. and Pinch, T. (Eds.) (1995), *Handbook of Science and Technology Studies*, Sage, London.
- Johnston, D., Sefcik, S. and Soderstrom, N. (2008), "The Value Relevance of Greenhouse Gas Emissions Allowances: An Exploratory Study in the Related United States SO₂ Market", *European Accounting Review* 17(4): 747-764.
- Kingdon, J. W. (1995), *Agendas, Alternatives and Public Policies*, Harper Collins College Publishers, New York, NY, USA.
- Kolk, A., Levy, D. and Pinske, J. (2008), "Corporate responses in an emerging climate regime: The institutionalization and commensuration of carbon disclosure", *European Accounting Review* 17 (4): 719-745.
- Kosoy, A. and Ambrosi, P. (2010), *State and trends of the carbon market 2010*, The World Bank Carbon Finance Unit, Washington, DC, USA.
- KPMG (2008), *Accounting for carbon: the impact of carbon trading on financial statements*, KPMG, London.
- Lash, J. and Wellington, F. (2007), "Competitive advantage on a warming planet", *Harvard Business Review* (March): 95-102.
- Lashof, D. A. and Ahuja, D. R. (1990), "Relative contributions of greenhouse gas emissions to global warming", *Nature* 344 (5): 529-531.
- Latour, B. (1999), *Pandora's Hope: Essays on the Reality of Science Studies*, Harvard University Press, Boston, Mass., USA.
- Laws, D. and M. Rein (2003), "Reframing practice", in Hajer, M. A. and Wagenaar, H., *Deliberative Policy Analysis: understanding governance in the network society*, Cambridge University Press, Cambridge, pp. 172-206.

- Lazarus, R. J. (2009) "Super wicked problems and climate change: Restraining the present to liberate the future", *Cornell Law Review* 94 (5): 1153-1233.
- Lim, B., Brown, S. and Schlamadinger, B. (1999), "Carbon accounting for forest harvesting and wood products: review and evaluation of different approaches", *Environmental Science and Policy* 2: 207-216.
- Litfin, K. T. (1994), *Ozone Discourses: Science and Politics in Global Environmental Cooperation*, Columbia University Press, New York, NY, USA.
- Lohmann, L. (2005), "Marketing and Making Carbon Dumps: Commodification, Calculation and Counterfactuals in Climate Change Mitigation", *Science as Culture* 14(3): 203-235.
- Lohmann, L. (2009), "Toward a different debate in environmental accounting: The cases of carbon and cost-benefit", *Accounting, Organizations and Society* 34 (3-4): 499-534.
- Lovell, H. (2004), "Framing sustainable housing as a solution to climate change", *Journal of Environmental Policy and Planning* 6 (1): 35-56.
- Lovell, H. (2010), "The treatment of carbon in financial accounts", paper presented at International Sociological Association (ISA) Congress 2010, New Orleans, USA.
- Lovell, H. and Mackenzie, D. (2011), "Accounting for carbon: The role of accounting professional organisations in governing climate change", *Antipode* 43 (3): 704-730.
- Lovell, H. and Smith, S. J. (2010), "Agencement in housing markets: the case of the UK construction industry", *Geoforum* 41 (3): 457-468.
- Lovell, H., Bulkeley, H. and Liverman, D. (2009a), "Carbon offsetting: sustaining consumption?", *Environment and Planning A* 41 (10): 2357-2379.
- Lovell, H., Bulkeley, H. and Owens, S. E. (2009b), "Converging Agendas? Energy and Climate Change Policies in the UK", *Environment and Planning C: Government and Policy* 27 (1): 90-109.
- Mackenzie, C. and Ascuí, F. (2009), *Investor leadership on climate change: An analysis of the investment community's role on climate change, and snapshot of recent investor activity*, UN Global Compact, New York, USA.
- Mackenzie, C., Hikisch, D. and Ivory, S. (2009), *UK Supermarkets 2009 carbon benchmark report*, ENDS Carbon, London.
- MacKenzie, D. (2006), "Working Paper - Producing Accounts: finitism, technology and rule following", available at: [www.sps.ed.ac.uk/ data/assests/pdf file/0010/3421/ProducingAccounts8Nov06.pdf](http://www.sps.ed.ac.uk/data/assests/pdf_file/0010/3421/ProducingAccounts8Nov06.pdf) (accessed 13 September 2009).
- MacKenzie, D. (2009), "Making things the same: Gases, emission rights and the politics of carbon markets", *Accounting, Organizations and Society* 34 (3-4): 440-455.
- McGready, M. (2008), "Accounting for Carbon", *Accountancy* 142 (1379): 84-85.
- Mathews, M. R. (1984) "A suggested classification for social accounting research", *Journal of Accounting and Public Policy* 3 (3): 199-221.
- Mathews, M. R. (1997) "Twenty-five years of social and environmental accounting research: Is there a silver jubilee to celebrate?" *Accounting, Auditing & Accountability Journal* 10 (4): 481-531.
- Michaelowa, A., Gagnon-Lebrun, F., Hayashi, D., Flores, L. S., Crête, P., and Krey, M. (2007), *Understanding CDM Methodologies: A guidebook to CDM rules and procedures*, Department for Environment, Food and Rural Affairs, London.
- Miller, C. (2001), "Hybrid management: Boundary organizations, science policy, and environmental governance in the climate regime", *Science, Technology, & Human Values* 26 (4): 478-500.
- Milne, M. (1996), "Capitalizing and appropriating society's rights to clean air: A comment on Wambsganss and Sanford's accounting proposal", *Critical Perspectives on Accounting* 7 (6): 681-695.

- Milne, M. and Gray, R. (2007) "Future prospects for corporate sustainability reporting", in Unerman, J., Bebbington, J. and O'Dwyer, B. (Eds.), *Sustainability accounting and accountability*, Routledge, London, pp. 184-207.
- Milne, M., Ball, A. and Gray, R. (2008), "Wither Ecology? The Triple Bottom Line, the Global Reporting Initiative, and the Institutionalization of Corporate Sustainability Reporting", paper presented at the American Accounting Association Annual Meeting, 3-6 August 2008, Anaheim, CA, USA, available at http://www.afaanz.org/openconf-afaanz2008/modules/request.php?module=oc_proceedings&action=proceedings.php&a=Accept+as+Paper (accessed 18 September 2009).
- Milne, M., Ball, A., and Mason, I. (2010), "The Kyoto seesaw: accounting for GHG emissions 2008 to 2012", *Chartered Accountants Journal* (February 2010): 25-27.
- Milne, M., Tregidga, H., and Walton, S. (2009), "Words not actions! The ideological role of sustainable development reporting", *Accounting, Auditing & Accountability Journal* 22 (8): 1211-1257.
- Ministry of the Environment, Japan (2009), *CDM/JI manual for project developers and policy makers*, Ministry of the Environment, Tokyo, Japan.
- Neeff, T. and Ascuri, F. (2009), "Lessons from carbon markets for designing an effective REDD architecture", *Climate Policy* 9: 306-315.
- New Energy Finance (2010), "The global carbon market increases by 5% in 2009", press release dated 18 January 2010, available at http://www.newenergymatters.com/download.php?n=NEF_PressRelease_2010_01_18_Marketactivity.pdf&f=pdf&t=pressreleases (accessed 18 January 2010).
- Nordhaus, W.D. (1991), "To slow or not to slow: the economy of the greenhouse effect", *The Economic Journal* 101: 920-937.
- Owen, D. (2008), "Chronicles of wasted time? A personal reflection on the current state of, and future prospects for, social and environmental accounting research", *Accounting, Auditing & Accountability Journal* 21 (2): 240-267.
- Padgett, J., Steinemann, A., Clarke, J. and Vandenberg, M. (2008), "A comparison of carbon calculators", *Environmental Impact Assessment Review* 28 (2-3): 106-115.
- Pales, J. C. and Keeling, C. D. (1965), "The concentration of atmospheric carbon dioxide in Hawaii", *Journal of Geophysical Research* 70 (24): 6053-6076.
- Parker, L. D. (2005) "Social and environmental accountability research: A view from the commentary box", *Accounting, Auditing & Accountability Journal* 18 (6): 842-860.
- Plattner, G., Stocker, T., Midgley, P. and Tignor, M. (Eds.) (2009), "IPCC Expert Meeting on the Science of Alternative Metrics. The Grand Hotel, Oslo, Norway, 18-20 March 2009: Meeting Report", available at: <http://www.ipcc.ch/pdf/supporting-material/expert-meeting-metrics-oslo.pdf> (accessed 29 January 2010).
- Power, M. (1991), "Auditing and environmental expertise: between protest and professionalization", *Accounting, Auditing & Accountability Journal* 4 (3): 30-42.
- Power, M. (1997), "Expertise and the construction of relevance: Accountants and environmental audit", *Accounting, Organizations and Society* 22 (2): 123-146.
- PricewaterhouseCoopers (2007), *Carbon value: Robust carbon management - a framework to protect and enhance shareholder value in response to climate change*, PricewaterhouseCoopers, Sydney, Australia.
- PricewaterhouseCoopers (2009) *Carbon Disclosure Project 2009: Global 500 Report*, The Carbon Disclosure Project, London.
- PricewaterhouseCoopers and IETA (2007), *Trouble-entry Accounting – Revisited*, PricewaterhouseCoopers, London.

- Rees, W. (1992), "Ecological footprints and appropriated carrying capacity: what urban economics leaves out", *Environment and Urbanization* 4 (2): 121-130.
- Rein, M. and Schon, D. (1993), "Reframing Policy Discourse", in Fischer, F. and Forester, F., *The Argumentative Turn in Policy Analysis and Planning*, UCL Press Ltd, London, pp. 145-166.
- Robson, K. (1992), "Accounting numbers as 'inscription': action at a distance and the development of accounting", *Accounting, Organizations and Society* 17(7): 685-708.
- Rodhe, H., Charlson, R. and Crawford, E. (1997), "Svante Arrhenius and the greenhouse effect", *Ambio* 26 (1): 2-5.
- Shackley, S. and Sohi, S. (Eds.) (2010), "An assessment of the benefits and issues associated with the application of biochar to soil: A report commissioned by the United Kingdom Department for Environment, Food and Rural Affairs, and Department of Energy and Climate Change", UK Biochar Research Centre, Edinburgh.
- Unerman, J., Bebbington, J. and O'Dwyer, B. (2007), *Sustainability accounting and accountability*, Routledge, London.
- United Nations (1992), "United Nations Framework Convention on Climate Change", available at: <http://unfccc.int/resource/docs/convkp/conveng.pdf> (accessed 10 January 2007).
- United Nations (1998), "Kyoto Protocol to the United Nations Framework Convention on Climate Change", available at: <http://unfccc.int/resource/docs/convkp/kpeng.pdf> (accessed 10 January 2007).
- United Nations Framework Convention on Climate Change (UNFCCC) (2006) *Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. Note by the Secretariat*, Decision FCCC/SBSTA/2006/9, available at: http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&prire=600003988#beg (accessed 18 September 2009).
- United Nations Framework Convention on Climate Change (UNFCCC) (2008), *Kyoto Protocol Reference Manual on Accounting of Emissions and Assigned Amount*, UNFCCC, Bonn, Germany.
- Villiers, C. d. and van Staden, C. J. (2006), "Can less environmental disclosure have a legitimising effect? Evidence from Africa", *Accounting, Organizations and Society* 31: 763-781.
- Wackernagel, M. and Rees, W. (1996), *Our Ecological Footprint: Reducing Human Impact on the Earth*, New Society Publishers, Gabriola Island, B.C., Canada.
- Wambsganss, J.R. and Sanford, B. (1996), "The problem with reporting pollution allowances", *Critical Perspectives on Accounting* 7 (6): 643-652.
- Wara, M. (2008), "Measuring the Clean Development Mechanism's performance and potential", *UCLA Law Review* 55 (6): 1759-1803.
- Watson, C. (2009), *Forest Carbon Accounting: Overview and Principles*, UNDP, UNEP and UNEP Risoe Centre, available at: <http://www.undp.org/climatechange/carbon-finance/Docs/Forest%20Carbon%20Accounting%20-%20Overview%20&%20Principles.pdf> (accessed 8 January 2010).
- World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) (2004) *The Greenhouse Gas Protocol: A corporate accounting and reporting standard* (Revised edition), World Business Council for Sustainable Development and World Resources Institute, Geneva, Switzerland and Washington, DC, USA.