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A review of carbon accounting in the social and environmental accounting literature: What can it contribute to the debate?

Francisco Ascui
University of Edinburgh Business School, University of Edinburgh, UK
francisco.ascui@ed.ac.uk

Abstract

This paper sets out to understand how carbon accounting has been tackled in the social and environmental accounting (SEA) literature, in order then to investigate what the preoccupations and gaps in this literature might tell us about the SEA 'project' more generally. It finds that the SEA literature on carbon accounting is already large, fast-growing, rich and varied. There is a mix of critical, philosophical or normative discussions about carbon accounting, and empirical studies of carbon accounting, with specific clusters of papers in carbon management accounting, carbon financial accounting, carbon disclosure and reporting, and carbon accounting education. Nevertheless, when compared with the scope of carbon accounting in practice, it is evident that there is considerable potential for social and environmental accounting researchers to broaden their engagement with other types of carbon accounting, in particular market-enabling, physical and political forms, and to collaborate with other professions and practitioners. Carbon accounting could be emancipatory: attracting new researchers into the SEA field, encouraging greater interdisciplinary cooperation and mutual learning, offering tremendous opportunities for engagement with practice and education, and helping to imagine new accountings free from the shackles of conventional accounting.

Keywords

Carbon accounting, carbon reporting, carbon disclosure

1. Introduction

This special issue aims to “move the social and environmental accounting literature in the direction of making a more ambitious contribution to broader debates about carbon accounting” (Larrinaga 2012, 55). Implicit in this aim is a perception that the social and environmental accounting (SEA) literature has not yet been sufficiently ambitious in tackling carbon accounting. This is at least an improvement on the “almost complete absence” of carbon accounting in the social accounting literature, observed in 2007 by Gray, Dillard, and Spence (17). Notable contributions since then have been seen particularly in special sections in *European Accounting Review* (2008) and *Accounting, Organizations and Society* (2009), and special issues of *Accounting, Auditing and Accountability Journal* (2011) and the *Journal of Cleaner Production* (2012).

This paper sets out to understand how carbon accounting has been tackled in the SEA literature to date, in order then to investigate what the preoccupations and possible gaps in this literature might tell us about the SEA ‘project’ more generally. In other words, I am interested in how tackling carbon accounting could potentially “move” the SEA literature in new directions – with implications for the understanding of carbon accounting, in the first instance, but hopefully also with secondary relevance for other areas of SEA research, such as biodiversity or water accounting.

This paper proceeds as follows. Section 2 briefly describes the research method. Section 3 reviews the SEA literature on carbon accounting, organising this within a subjective classification framework. Section 4 then provides some observations on the reviewed literature as a whole, and compares the coverage of this literature with the scope of carbon accounting as experienced in practice, leading to the paper’s findings and conclusions.

The purpose of the exercise is to invite debate, and to identify areas of research which could potentially serve to extend our understanding of social and environmental accounting and accountability, as well as contributing to our understanding of carbon accounting.

2. Research method

In keeping with several well-regarded reviews of the SEA literature (Parker 2005; Owen 2008; Parker 2011) I included four leading interdisciplinary accounting journals within the scope of the review: *Accounting, Auditing and Accountability Journal* (AAAJ), *Critical Perspectives on Accounting* (CPA), *Accounting Forum* (AF) and *Accounting, Organizations and Society* (AOS). To this I added the two further journals dedicated to SEA research, also included in Parker (2005; 2011): *Social and Environmental Accountability Journal* (SEAJ) and the *Journal of the Asia Pacific Centre for Environmental Accountability* (JAPCEA). Finally, I included *European Accounting Review* (EAR) in view of its special section on carbon accounting in 2008, and the *Journal of Cleaner Production* (JCP), both because of its special issue on carbon accounting in 2012, and because of its prominence in the environmental management accounting (EMA) literature as reviewed by Schaltegger and Zvezdov (2011). I have thereby included all of the top five and seven out of the top ten journals with the most publications on EMA (Schaltegger and Zvezdov 2011, 13).

Carbon accounting papers were identified using the full-text keyword searches available for these journals through ScienceDirect (AOS, AF, JCP and CPA), Emerald (AAAJ) and Taylor and Francis (SEAJ and EAR). For JAPCEA, individual issues from 2008 onwards were downloaded from the journal website, and then searched.¹ As the term “carbon accounting” is not necessarily used by all commentators on the subject, it was supplemented with keyword

searches for “carbon footprint”, “carbon * accounting” and “climate * accounting” (thus picking up terminology such as ‘carbon emissions accounting’, ‘carbon dioxide accounting’ or ‘climate change accounting’). In general, searching for “carbon” AND “accounting” was sufficient to identify the relevant papers, except in JCP, where the other keywords yielded many further results. Articles making only peripheral reference to carbon accounting or including carbon as only one of many environmental factors, articles in press at the time of searching (April 2013), paper/book reviews and announcements were then excluded. This led to identification of a total of 89 papers on carbon accounting in the selected journals, all but four published from 2008 onwards. More than two-thirds (64) were in a single journal (JCP). The results were cross-referenced against a review of the carbon accounting literature (not limited to the SEA literature) carried out by Stechemesser and Guenther (2012), showing that the present review, while narrower in overall scope, is more inclusive with respect to these particular journals, only some of which is attributable to being carried out at a later date. The results are summarised in Table 1. In order to present this on a single page, 55 empirical studies in JCP are not individually listed; however, the existence of this literature is acknowledged and examples are discussed in the next section.

Each paper was read and summarised by the author, and these summaries were used to construct a subjective classification of the literature. The categorisations developed for the SEA literature by Mathews (1984; 1997; 2000; 2004) were considered as a possible framework, although in keeping with Mathews’ approach, the clusters eventually proposed reflect the author’s perceptions of emergent themes rather than a priori expectations. These clusters are presented in the next section, with brief descriptive summaries of the papers within each cluster.

A final objective was to identify potential gaps in the literature, especially with respect to differences between the scope of academic research and practice, in order to facilitate the kind of engagement of research with practice and education called for by Bebbington (1997). Identifying gaps is problematic for a new field such as carbon accounting, as it assumes some conception of the ‘whole’. Nevertheless, to some extent the literature itself tells us about what it does not cover (e.g. suggestions for further research which have not been taken up). A higher-level view of potential gaps was obtained by mapping the literature against the five ‘frames’ of carbon accounting identified in Ascui and Lovell (2011). The results of this are shown in Figure 2 in section 4.

Any review such as this has to draw boundaries and leaves out some relevant material. Also, the subjective nature of the classification process and identification of emergent categories means that other researchers could discover different clusters which could yield different insights. I hope that my subjective opinion has value as it is informed by experience: in addition to researching and teaching carbon accounting as an academic, I can claim 14 years of practitioner experience carrying out various different carbon accounting activities, including early product footprints, organisational emission inventories, project-based emission reduction accounting methodologies and accreditation of greenhouse gas auditors.

3. Carbon accounting in the social and environmental accounting literature

The literature on carbon accounting in the target journals is summarised in Table 1. Inevitably, this review has excluded certain papers that others might judge should be included. In particular, it excludes some papers even within special sections or issues on carbon accounting, such as Braun (2009) and Callon (2009) in AOS, which deal with

sociological aspects of carbon markets in general, rather than carbon accounting in particular, and Boston and Lempp (2011) in AAAJ, which discusses the broader question of why dealing with climate change is such a “super wicked problem” (R. J. Lazarus 2009) from a policy perspective. Papers dealing with sulphur dioxide emissions accounting have also been excluded, despite the historical relevance of this to corporate carbon accounting (Johnston, Sefcik, and Soderstrom 2008; Freedman and Stagliano 2008).

In addition, the limitation to specific journals excludes much literature on carbon accounting in other journals which could be considered as being within the SEA literature, such as Lodhia (2011) on corporate carbon reporting in Australia; Knox-Hayes and Levy (2011) on the politics of carbon disclosure as a form of governance; Lippert (2012) on corporate carbon accounting as performative practice; Freedman and Jaggi (2005) on the determinants of carbon disclosure, and many others, in addition to a vast grey literature. I refer the reader to Stechemesser and Guenther (2012) for a broader-ranging review, though still with certain limitations.

After summarising this literature, the first major distinction that was apparent was between critical, philosophical or normative discussions *about* carbon accounting in general, and empirical studies *of* carbon accounting, although sometimes the distinction was not clear, for example when an empirical study concludes with normative suggestions for practice, or when a critical paper cites empirical evidence. Nevertheless, it could serve as one useful dimension for classification, broadly consistent with Mathews' (1997, 482) categories of normative statements and empirical studies within the SEA literature. However, it was not entirely satisfactory for the purposes of categorising the carbon accounting papers in this review.

A clearer set of clusters appeared based on common subject matter rather than approach. First was the aforementioned set of largely critical, philosophical or normative discussions *about* carbon accounting as a subject in itself (13 papers). The second, and by far the largest, set of papers (56 papers, all but one in JCP) focussed on what might be termed carbon management accounting, or the application of environmental management accounting (EMA) techniques to carbon. These were universally empirical in nature, although some concluded with normative statements. A third group of 15 papers, mostly also empirical in nature, analysed carbon disclosure and reporting, often within the framework of legitimacy theory. I have included two papers on carbon auditing or assurance within this group, which could well be regarded as a separate cluster in future (as with environmental audit in Mathews [2000]). A fourth cluster (4 papers) focussed on financial accounting and reporting of allowances or permits under emissions trading schemes, or what I will term here ‘carbon financial accounting’. These were mainly critical, philosophical or normative. Finally, one paper addressed carbon accounting education. These clusters have been used to organise the following discussion.

¹ <http://www.unisa.edu.au/Research/CAGS/APCEA/Journal/>

Table 1: Summary of carbon accounting research in the SEA literature

Journal	Count	Cross-check	Papers	Discussions about carbon accounting	Carbon management accounting	Carbon disclosure and reporting	Carbon financial accounting	Carbon accounting education
European Accounting Review	2	2	Bebbington and Larrinaga-González 2008			Kolk, Levy, and Pinkse 2008		
Accounting, Organizations and Society	5	3	Hopwood 2009; MacKenzie 2009; Lohmann 2009	Engels 2009			Cook 2009	
Accounting, Auditing and Accountability Journal	11	4	Milne and Grubnic 2011; Ascui and Lovell 2011; Bowen and Wittneben 2011; McNicholas and Windsor 2011			Rankin, Windsor, and Wahyuni 2011; Cooper and Pearce 2011; Solomon et al. 2011; Haigh and Shapiro 2012; Lodhia and Martin 2012; Green and Li 2012; Hrasky 2012		
Journal of Cleaner Production	64	0	Schaltegger and Csutora 2012; Stechemesser and Guenther 2012; Burritt and Tingey-Holyoak 2012; Ascui and Lovell 2012; Móznér 2013	55 papers (a selection cited in section 3.2)		Gallego-Álvarez, Rodríguez-Domínguez, and García-Sánchez 2011; Dragomir 2012; Sullivan and Gouldson 2012; Pellegrino and Lodhia 2012		
Critical Perspectives on Accounting	2	0					Mete, Dick, and Moerman 2010; Moore 2011	
Accounting Forum	1	1				Andrew and Cortese 2011		
Social and Environmental Accountability Journal	1	0						de Aguiar and Fearfull 2010
Journal of the Asia-Pacific Centre for Environmental Accountability	3	1				Chatterjee 2012; Qian 2012	Zhang-Debreceeny, Kaidonis, and Moerman 2009	
Total	89	11	13	56	15	4	1	1

3.1. Discussions *about* carbon accounting

These papers typically appear in special sections or issues on carbon accounting and include the editors' contributions as well as a number of other wider-ranging papers that engage in a critical debate about the nature of carbon accounting, the actors involved and how it is performed in practice. They typically draw on empirical evidence, often in more than one area, but with the aim to illustrate and support normative or critical statements about carbon accounting, rather than with the intention of satisfying a need for empirical answers to a practical problem. They often use a combination of methods, typically including interviews, content analysis, textual and discourse analysis.

In EAR, Bebbington and Larrinaga-González (2008) provide an excellent introduction to research into corporate accountability to stakeholders for their climate change impacts. They consider three accounting implications of global climate change for companies: financial accounting of emission allowances under emissions trading schemes; accounting and reporting for climate change risks to corporate performance; and accounting and reporting for the uncertainty associated with climate change, which they believe calls for an integrated, precautionary, participatory and interdisciplinary approach, as opposed to utilitarian cost/benefit analysis. In relation to this last point, they reiterate calls for accounting research to be normative (Gray 2002) and for greater researcher engagement with practice (Parker 2005; Adams and Larrinaga-González 2007), for example to help identify forms of carbon accounting practice which would lead to lower-carbon organisations.

Hopwood (2009) introduces the other papers in the 2009 special section of AOS by way of the observation that increasing human and organisational interaction with the environment implies ever-growing demands for flows of information, which often depend upon a variety of complex assessments and calculations. The author acknowledges the development of new agendas and changes in conventional approaches in various areas of accounting, such as environmental reporting, cost/benefit analysis, project appraisal and discounting, before delving into the issues raised by the creation of carbon markets, which are the subject of further papers in the special section. Hopwood questions whether the ethical concerns about the environment which gave rise to carbon markets are reconcilable with the values brought to carbon markets in their practical implementation. The author notes that while accounting has been involved in carbon markets, accounting research "has so far seemingly lagged behind that in the environmental and social sciences." (435).

MacKenzie (2009) explores how carbon markets are constructed or 'performed' as a social process, and in particular, how the characteristics of markets depend in part on the 'calculative mechanisms' (Callon and Muniesa 2003) which make them up. The paper discusses two examples of this: how different greenhouse gases are made commensurable, and how to account financially for emission allowances. Drawing on actor-network theory, MacKenzie explores details of both the physical technology (e.g. power plants, metering systems) and the 'black-boxed' accounting constructs such as the concept of Global Warming Potential, which together form the basis for commensuration, in carbon markets, of emissions of one gas in a certain location with reductions in emissions of another gas in another part of the world. In his second case study, MacKenzie draws on the notion of 'finitism' – essentially that past classifications influence present classification attempts – in his discussion of the debate over the nature of emission allowances that occurred in the run-up to the start of the EU Emissions Trading Scheme (EU ETS) in 2005 (discussed further in Cook [2009]). Despite pointing out many failings in carbon markets, MacKenzie is optimistic

about the potential for improvement, and calls for multiple ‘witnesses’ – including professionals as well as academics from multiple disciplines and countries – to assist in a process of social learning to reshape institutions to mitigate climate change.

Lohmann (2009) examines the “conflicts, contradictions and resistances engendered by environmental accounting techniques and the perpetually incomplete efforts of accountants and their allies to overcome them” (499), focussing specifically on cost-benefit analysis and carbon accounting and, like MacKenzie (2009), highlighting the ways in which accounting procedures are both socially constructed, and in turn, socially constitutive. He uses the concept of ‘framing’, which creates new ‘outsides’ or ‘overflows’ in every attempt to bring something ‘inside’, as a way of drawing attention to and understanding the dynamic, unstable and incomplete nature of accounting practices, thus aiming to help both defenders and critics of carbon accounting to engage with each other’s concerns. Lohmann focuses his analysis of carbon accounting specifically on the practice of carbon offsetting, putting the Kyoto Protocol’s Clean Development Mechanism (CDM) in the context of earlier US pollution offsetting schemes set up in the late 1970s. He discusses a variety of ‘overflows’ from carbon offsetting as a commensuration and framing process, such as perverse disincentives to invest in low-carbon innovation, debatable baselines and ‘additionality’ of emission reductions, and unclear project boundaries.

The special issue of AAAJ in 2011 on ‘Climate Change, Greenhouse Gas Accounting, Auditing and Accountability’ was the first entire issue of a leading SEA research journal devoted to the subject (in fact an issue and a half, as it continued with a further set of papers in 2012). Special Issue editors Milne and Grubnic (2011) emphasize the importance of interdisciplinary perspectives to SEA research, highlighting contributions from several different disciplines within the special issue. They then look at the potential impact of a cost of carbon on Air New Zealand, and point out that the growth in aviation emissions from New Zealand’s tourism sector outstrips any feasible offsetting potential within the country, raising the important point that “everybody cannot offset” (955). Turning to national carbon accounting, they show how complex, uncertain and challenging it is to create a national carbon account under the Kyoto Protocol, raising many areas worthy of further research, such as the robustness of data, assumptions and models, and the processes for developing and auditing these calculative techniques.

Ascui and Lovell (2011) start by pointing out that carbon accounting means many different things to many different people, proposing a broader ‘pick and mix’ definition in order to widen the debate. This definition includes a wide range of accounting activities, performed on various subjects at different levels, for a variety of mandatory and voluntary purposes (980). The authors seek to make sense of this diversity through the concept of framing, identifying five key frames associated with different communities of practice: physical, political, market-enabling, social/environmental and financial carbon accounting. They suggest that only by recognising these multiple framings can we make sense of the tensions between different understandings of carbon accounting, and thus “encourage constructive learning and policy change” (982). Finally, they call for carbon accounting to be recognised as a new research agenda, “worthy of investigation in itself... as well as in its manifold practical applications” (992) and make a plea for such research to be interdisciplinary and practice-oriented.

Bowen and Wittneben (2011) similarly highlight the different carbon accounting activities undertaken by different “organisational fields” (1025) and note the relative lack of communication and understanding across these fields, which they identify as: “counting

carbon” (largely to do with scientific measurement); “carbon accounting” (concerned with carbon management data within firms); and “accountability for carbon” (covering governance issues to do with allocating responsibilities for emissions, at a variety of levels from transnational to governmental and non-governmental) (1026-8). The authors go on to discuss “a real incongruence among the three fields in the importance they ascribe to accuracy, consistency and certainty in the reporting of carbon emissions” (1029). Like Ascui and Lovell (2011), the authors believe that understanding the tensions within and between fields can be illuminating and constructive. Some lessons they draw from discussions with stakeholders include that we should be wary of locking in standards too early, and that “we may not need accurate accounting, but rather controllable accounting that can evolve over time” (Bowen and Wittneben 2011, 1032).

McNicholas and Windsor (2011) discuss carbon accounting towards the end of a broader critique of the “financialisation of the atmosphere” (1074). The link is made between the issue of ‘fair value’ in carbon financial accounting (also discussed by Cook [2009]) and the role of ‘fair value’ accounting in the global financial crisis, arguing that in both cases it creates room for creative accounting. The authors object to focussing carbon accounting on the financial issues raised by emissions trading schemes, arguing that a different conceptual framework, such as material and energy flow accounting, is required to measure greenhouse gas emissions in a broader social and environmental context.

A special issue on ‘Climate accounting and sustainability management’ was published in JCP in November 2012. Schaltegger and Csutora (2012) provide an introduction and overview, putting carbon accounting in the context of sustainable development, where they point out that globalisation is causing shifts in emissions from industry to transportation, and from industrialised countries to emerging markets. The increasing share of ‘hidden’ emissions embodied in imported goods underscores the importance of product carbon LCA, as seen elsewhere in the journal, although they acknowledge the challenges that complex supply chains create for this type of carbon accounting. The authors discuss the fact that carbon accounting is relevant at different geographical and institutional levels, before turning to focus on corporate carbon management accounting, which they propose can be divided into ‘accounts of un-sustainability’ (i.e. climate change impacts) and ‘accounts for sustainability improvements’ (emission reduction measures) (4). They break these down further into backward-looking efforts to understand past and present performance, forward-looking forecasting of future emissions, identification of emission reduction potentials, and supporting the implementation of carbon management measures. The authors present a framework for corporate carbon management accounting which distinguishes activities according to whether the information is physical or monetary; past- or future-oriented; routinely generated or ad-hoc; and short- or long-term in outlook (similar to Burritt, Schaltegger, and Zvezdov 2011). They also discuss the way in which different functional units of an organisation require different forms of carbon management accounting – e.g. top management may want to know the company’s overall carbon footprint whereas the marketing department may be interested in carbon labelling and the finance department in valuing and reporting emission allowances. This leads to a call for greater interdisciplinary collaboration between scientists, practitioners, accountants and engineers to develop practical and differentiated accounting tools to support these different needs.

Stechemesser and Guenther (2012) observe that no consistently applied definition of carbon accounting exists, and aim to establish one through a systematic literature review. They identify and analyse 129 sources which mention carbon accounting, using a similar search method to this review, but without any limitation with respect to journals, and including

some grey literature. They observe an increasing trend in publication, with most papers published from 2008 onwards. A variety of disciplines are represented: accounting and management (21%), environmental sciences (19%), practitioners (19%), natural sciences (16%), engineering (10%), social sciences (9%) and economics (6%). 58% of the publications were empirical studies, 38% conceptual and the remainder practitioner oriented. The authors identify 11 different definitions of carbon accounting (including from Bebbington and Larrinaga-González 2008; Kolk, Levy, and Pinkse 2008; Ascui and Lovell 2011; Bowen and Wittneben 2011). Using citation analysis to identify clusters of similar publications, they identify four scales of carbon accounting: organisational (35% of publications), national (28%), project (25%) and product (9%) scales. The authors conclude that an over-arching definition of carbon accounting is possible, yet at the same time acknowledge that “researchers from different disciplines, but even within one research field, have a different understanding as to what carbon accounting is” (Stechemesser and Guenther 2012, 35–36).

Burritt and Tingey-Holyoak (2012) ask whether there is a gap between academic and practitioner accountants in relation to carbon accounting. Analysing survey responses from 12 accountancy firms in South Australia, the authors generate preliminary observations that these firms are using only a few out of a set of 20 ‘known’ sustainability accounting instruments. The authors suggest that clients, professional bodies, governments, regulators and standard-setters can all help to change the relationship between carbon accounting research and practice. Finally, they note the important role of education in the research-teaching-practice triangle.

Ascui and Lovell (2012) point out that because carbon accounting is an activity with important social and economic consequences, currently carried out by many different communities, it is unsurprising that we can observe emerging tensions between communities over the boundaries of professional expertise in this area. They draw on the concepts of epistemic communities (Haas 1992a; Haas 1992b; Adler and Haas 1992), boundary-work and boundary organisations (Gieryn 1983; Guston 2001; Miller 2001) to help explain the ways in which different communities involved in carbon accounting share a world-view which conditions or frames their understanding of carbon accounting, including perceptions of how and by whom it should be done. Practical examples are given of discursive strategies being employed to re-frame carbon accounting. Finally, they investigate the stakeholders involved in the Climate Disclosure Standards Board, arguing that despite it being the site of productive cooperation between accountants and environmental NGOs, this should not go unscrutinised, both because of the possible exclusion of other viewpoints and because of the large financial benefits that may in future accrue to those who successfully claim competence in carbon accounting.

A paper in JCP by Móznér (2013) was difficult to classify. It is largely an empirical study, with countries as the unit of analysis, using input-output modelling to evaluate the significance of consumption-based carbon accounting, as opposed to the production-based accounting of the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol. However, the author notes that this is an issue with major political and ethical implications, and also discusses the different features of carbon footprints, noting variations in monetary versus physical carbon accounting, different system boundaries, scopes, measurement units, and degree of decomposition into component parts.

3.2. Carbon management accounting

Virtually all of the carbon management accounting literature appears in JCP. It tends to be empirical and positivist rather than interpretive or critical, reflecting broader divisions

between critical SEA and mainstream EMA literatures more generally (Schaltegger and Zvezdov 2011). The journal has a long history of publication of Life Cycle Assessment (LCA) case studies, which often include greenhouse gas emissions, or associated damages, as one of many environmental impacts. The first example that I could identify, in JCP, of an LCA study focussing exclusively on greenhouse gas emissions was by Gielen, Moriguchi, and Yagita (2002), investigating the potential of various options to reduce emissions in the Japanese petrochemicals sector. Other early papers were published in 2003 (Reijnders and Huijbregts, on life cycle emissions of biofuels), 2005 (Karlsson and Pigretti Öhman 2005, on emissions associated with medical products) and 2007 (Reijnders and Huijbregts 2007, again on biofuels). The literature then explodes with around 37 carbon LCA papers published from 2009 onwards, calculating carbon footprints for a vast array of products and services, from pineapples (Ingwersen 2012) to houses (Salazar and Meil 2009) and water supply (Friedrich, Pillay, and Buckley 2009). The authors of such studies frequently draw attention to the fact that their results are significantly influenced by key assumptions, such as the choice of system boundary, functional unit, emission factors, allocation rules, data sources, geographical location and accounting methodology. While some studies compare different methods (e.g. Dias and Arroja 2012; Scipioni et al. 2012), there is a surprising lack of meta-analyses, or of more interpretive studies of what this uncertainty implies for stakeholders relying on such information.

A smaller set of papers, all published from 2011 onwards, use economic input-output models to estimate the carbon footprint of entire sectors, regions or economies, such as Chinese households (Liu et al. 2011; Fan et al. 2012), Finnish forestry (Ståhls, Saikku, and Mattila 2011), a Norwegian county (Larsen and Hertwich 2011) and the Finnish economy (Seppälä et al. 2011). Often such input-output studies differ from LCA in that they allocate responsibility for emissions to consumption, rather than production of a good or service. Some papers combine both methods (e.g. Virtanen et al. 2011), and a small number of papers use activity-based methods developed by the Intergovernmental Panel on Climate Change, or variations thereof, to calculate or allocate responsibility for emissions from sectors such as rubber production in Thailand (Jawjit, Kroeze, and Rattanapan 2010) or land use change in general (Ponsioen and Blonk 2012).

Another set of JCP papers focus on carbon management accounting at the organisational level. For example, Güereca, Torres, and Noyola (2013) calculate the carbon footprint of the Institute of Engineering at a Mexican university and use this to propose emission reduction actions. Lee (2012) investigates the effectiveness of eco-control methods in identifying and measuring carbon performance in several companies in the Korean car manufacturing industry. Bradley, Druckman, and Jackson (2013) put forward a model for estimating emissions for small and medium-sized enterprises from higher-level data. Tsai et al. (2012) use a case study with a Taiwanese pulp and paper company to integrate information about the cost of carbon and other externalities through Activity-Based Costing.

A more sociological perspective is taken by Upham, Dendler, and Bleda (2011) in their study of public perceptions (via focus groups) of a UK carbon labelling trial, finding that consumers find it very difficult to make sense of carbon labels and are unlikely to use them for product selection. The authors make the case for carbon labels to be used instead as an indicator of commitment to a programme of reducing emissions, rather than simply reporting a specific quantity of emissions (affirming the approach to carbon labelling taken by the UK's Carbon Trust).

Engels' (2009) contribution to AOS promises to be a study of "how companies learn to account for carbon" (488), but is perhaps more accurately described as a study of how companies initially responded to the imposition of a carbon market as a new form of regulation, describing the sources of information and expertise that they drew upon, and how they configured themselves internally to respond to the change in their external regulatory environment. The results tell us about, for example, the relative importance (at that early stage) of management accounting and control units, as opposed to environmental or trading units.

3.3. Carbon disclosure and reporting

The papers in this cluster start with EAR and continue through the special issues of AAAJ and JCP, with further contributions found in AF and JAPCEA. In their early contribution, Kolk, Levy, and Pinkse (2008) examine carbon disclosure and reporting as an emergent corporate response to climate change. They set out the context of changing corporate responses to climate change, from oppositional towards more proactive strategies, observing the development of carbon management, accounting and reporting capacities as being driven partly by (expectations of) government requirements, and also by pressure from investors and environmental non-governmental organisations (NGOs). They draw on the concept of institutional entrepreneurship to help explain the emergence of carbon disclosure as a new form of governance, noting the use by environmental NGOs of investors as way of leveraging 'strategic power' (Levy and Scully 2007) to achieve their objectives. They highlight the critical reliance of carbon accounting on commensuration (Espeland and Stevens 1998), pointing out that this process is both technical and political in nature. The authors then show, through an analysis of Carbon Disclosure Project (CDP) responses from FT500 companies published in 2007, that commensuration was not yet achieved, due to factors such as variations in the questionnaire over time, inconsistency in respondent approaches to questions, use of different carbon accounting standards, different choices regarding organisational boundaries, geographic and gas coverage, and inconsistent auditing or verification. This leads them to conclude that "neither the level of carbon disclosure that CDP promotes nor the more detailed carbon accounting provide information that is particularly valuable for investors, NGOs or policy makers at this stage." (Kolk, Levy, and Pinkse 2008, 719).

In AAAJ, Rankin, Windsor, and Wahyuni (2011) call on institutional governance systems theory to help explain voluntary greenhouse gas reporting in Australia in 2007, in the absence of mandatory reporting requirements. Using data from 80 S&P ASX300 companies, the authors find that energy, mining and industrial firms are more likely to report greenhouse gas emissions voluntarily than consumer or services industry firms. Other factors associated with disclosing firms include having an Environmental Management System in place, having this certified, having higher corporate governance quality, and publicly reporting to the CDP.

Cooper and Pearce (2011) examine climate-related performance measurement and reporting from English local authorities, through a combination of documentary analysis and interviews. A number of limitations with the measurement framework are pointed out, such as incomplete coverage of emissions, unclear 'additionality' of reported emission reductions, and unclear accountability when responsibilities are shared between central and local governments. Nevertheless, the authors also discern some positive outcomes, such as evidence that the process has focussed minds, built capacity and encouraged local authorities to pay more attention to their use of energy.

Solomon et al. (2011) point towards acknowledged weaknesses in public disclosure of corporate climate change risks, opportunities and responses, or what they term 'public climate change reporting', which leads them to question whether information disclosed privately to institutional investors is any more effective. Applying discourse analysis to data from interviews with 20 UK institutional investors, the authors find that institutional investors are demanding detailed climate change risk and opportunity information from companies. However, the authors note the "complete absence of any ethical discourse" (1140) in private climate change reporting, echoing concerns raised in different contexts by Cooper and Pearce (2011), McNicholas and Windsor (2011), and others.

Haigh and Shapiro (2012) focus on the decision-usefulness of carbon reporting information for financial institutions. They identify a 'discourse of the imaginary' implicit in finance professionals' visions for the future, which is used by such professionals to justify non-traditional investment criteria. The authors then compare mandatory carbon reporting under the Kyoto Protocol, EU ETS and EU Integrated Pollution Prevention and Control Directive with four voluntary approaches (input-output analysis, structural decomposition analysis, British Standard PAS 2050 and the Greenhouse Gas Protocol). Broadly, the authors' findings support the evidence cited by Solomon et al. (2011) regarding the shortcomings of public climate change reporting in terms of investor decision-usefulness.

Lodhia and Martin (2012) apply a combination of coding and content analysis to 105 written submissions to a consultation on the Australian National Greenhouse and Energy Reporting (NGER) Act of 2008. While most of the paper concerns identification of the different stakeholder groups and their key concerns, general support for a consistent framework for carbon accounting, moving from (then) voluntary to mandatory reporting, was noted, along with a need for independent assurance. The authors observe that the views of CPA Australia (the accountancy professional body) "suggested that the accounting profession would be in the best position to facilitate auditing processes, even though this task would be beyond the realm of the most accountants' expertise" (138).

Green and Li (2012) examine whether an expectation gap exists between different Australian stakeholders in relation to assurance of greenhouse gas reporting, by surveying emission report preparers, assurers and users (non-institutional shareholders). They find evidence of an expectation gap with various dimensions. For example, shareholders had higher expectations of assurers than assurers themselves in relation to responsibilities for accurate record-keeping and internal controls. Assurers also placed higher importance on auditing rather than engineering and environmental science expertise, emphasised more by shareholders. In keeping with other studies, the authors found that all groups considered assured emission reports not to be decision-useful (however, this may also relate to the lack of a mandatory carbon price in Australia at the time of the survey). They conclude that standard setters such as the International Auditing and Assurance Standards Board (IAASB) must not only consider expectation gaps in their standard setting, but also proactively seek to educate users as to the purpose and limitations of greenhouse gas assurance.

Hrasky's (2012) study examines the disclosure strategies of Australia's ASX Top 50 companies, based on content analysis of their sustainability and annual reports for 2005 and 2008. The author finds that, consistent with an increased need for legitimation in the face of heightened public awareness of climate change, companies are disclosing more greenhouse gas emissions information. More disturbingly, the author also observes an increase in emphasis on symbolic information, associated with a pragmatic approach to seeking legitimacy, particularly for non-intensive sectors. On the other hand, there was a significant

increase in the disclosure of behavioural actions by the carbon intensive industries, indicating a shift towards a moral legitimization strategy. However, the author cautions that organisational accounts of behavioural action may not reflect real changes in operations and impact, and short-term actions may be insufficient to achieve long-term climate objectives.

In JCP, Gallego-Álvarez, Rodríguez-Domínguez, and García-Sánchez (2011) analyse the factors associated with the level of corporate disclosure of opportunities arising from climate change. Taking their cue from legitimacy theory, the authors test for correlations between environmental performance (defined as 2007 emissions per unit revenue), economic performance (defined as Return on Assets) and location (whether headquartered in a country that has ratified the Kyoto Protocol) with respect to the volume of disclosure on opportunities arising from climate change in a sample of sustainability reports from 162 international companies. They suggest that environmental performance and location in a Kyoto Protocol country are determinants of such disclosure, whereas economic performance is not.

Dragomir (2012) analyses the disclosure of greenhouse gas emissions information in the last decade's sustainability reports from Europe's five largest oil and gas companies. The author finds significant gaps and shortcomings in the data presented by the five companies, as compared with the requirements of the Greenhouse Gas Protocol, especially with respect to clarity over methodological issues, uncertainty, and re-statements of current and base year emissions. Nevertheless, this longitudinal study does show that data quality and standardisation has improved over time.

Sullivan and Gouldson (2012) investigate the debate between investors and companies reporting through initiatives such as the CDP over the utility of this information. From an analysis of carbon disclosure by UK supermarkets, they conclude that while investors have encouraged companies to report, they have paid far too little attention to the quality of the data, while at the same time, reported data fall short of comparability requirements for investors. The authors consider the potential role of mandatory reporting and point out that while it offers an opportunity to improve the quality and comparability of reported information, companies will inevitably retain some discretion, and more prescriptive reporting could potentially mask company-specific insights. They therefore conclude that the best way forward would be through a combination of voluntary and mandatory reporting, together with active investor interest in the reported data.

Pellegrino and Lodhia (2012) use legitimacy theory as their framework for exploring how two companies and two industry bodies in the Australian mining industry have used carbon disclosures through different media to ensure their on-going legitimacy. They find that "disclosures may not only contribute to maintaining organisational legitimacy, but also system-wide legitimacy for an entire industry" (78). The authors also note that the use of a wide range of communication media indicates the existence of multiple stakeholders or 'publics' with whom legitimacy is being sought.

In AF, Andrew and Cortese (2011) explore the role of discourse in shaping carbon disclosure regulation, focussing on the CDP as a voluntary 'self-regulatory' framework. Like many others in this group, the authors find that variances in carbon accounting methodologies used by firms reporting to the CDP inhibit comparability and decision-usefulness of the information. The authors express concern that "self-regulatory devices such as the CDP may further entrench the current economic status quo as the only path to a more environmentally responsible future" (133).

In JAPCEA, Chatterjee (2012) uses content analysis of carbon disclosure in corporate sustainability reports of 14 multinational mining and oil companies to evaluate the influences on corporate decisions to have their disclosures independently verified. The author finds that companies operating within a stronger policy environment and with a stakeholder-oriented (as opposed to shareholder-oriented) business culture are more likely to opt for independent assurance. The author calls for adoption of a single commonly accepted standard for corporate carbon disclosure and independent assurance.

Qian (2012) examines carbon efficiency (a sub-set of eco-efficiency – Schaltegger and Burritt 2000), which they define as economic value generated per unit of reported greenhouse gas emissions, for Australian companies over 2008-2010, finding that environmentally sensitive industries display relatively high efficiency for Scope 2 emissions but relatively low efficiency for Scope 1 emissions; while the reverse is the case for less environmentally sensitive industries. The author also finds little significant change in carbon efficiency since the introduction of mandatory reporting in Australia in 2008.

3.4. Carbon financial accounting

This set of papers is spread across AOS, CPA and JAPCEA. In AOS, Cook (2009) provides a detailed account of the failed attempt by the International Accounting Standards Board (IASB) through its International Financial Reporting Interpretations Committee (IFRIC) to regulate the financial accounting of carbon allowances in 2005, arguing that it was precisely the features of carbon markets that made them attractive to policy-makers (placing a cost on a previously costless activity; mitigating the impact of this by providing a certain amount of free allowances, and making allowances tradable) which created accounting difficulties under existing standards. The author discusses the various accounting options, and evaluates the solution originally put forward by IFRIC, concluding that the IASB is caught between the need for consistency with other standards, and the unique challenges raised by a 'frontier' issue such as accounting for carbon allowances.

In CPA, Mete, Dick, and Moerman (2010) explore the different meanings associated with the term carbon 'permit' in Australia from accounting and taxation institutional perspectives. The authors analyse and deconstruct the rhetoric used by various institutional stakeholders to claim ownership of the meaning of the term, pointing out for example that the accounting institution views a carbon permit as an asset, within a metanarrative of the market, whereas the taxation institution views a carbon permit as a deduction or cost, within its metanarrative of regulation and compliance. According to the authors, "The result is that the carbon permit (one 'thing') has a different meaning according to the two institutions which cannot be reconciled." (628). They point out that this has practical implications: for example, if carbon permits are seen only as a deduction rather than an asset from a taxation perspective, they will not be subject to capital gains tax.

Moore (2011) uses structuration theory to help understand the conflicts and unintended consequences which led to the withdrawal of *IFRIC Interpretation 3: Emission Rights* (IFRIC 3) in June 2005. Moore argues that the introduction of the EU ETS exposed structural contradictions between *IAS 37 Provisions, Contingent Liabilities and Contingent Assets* and *IAS 38 Intangible Assets*. The issuance of IFRIC 3 in turn led to conflict in terms of legitimacy and domination between the IASB, European Commission and the European Financial Reporting Advisory Group (EFRAG). Finally, the author argues that the subsequent joint IASB and US Financial Accounting Standards Board (FASB) agenda project on emissions trading demonstrates these organisations' need for 'ontological security' and "therefore seeking to

reshape the accounting signification structure with regard to ETS, as well as the domination and legitimation structures” (223).

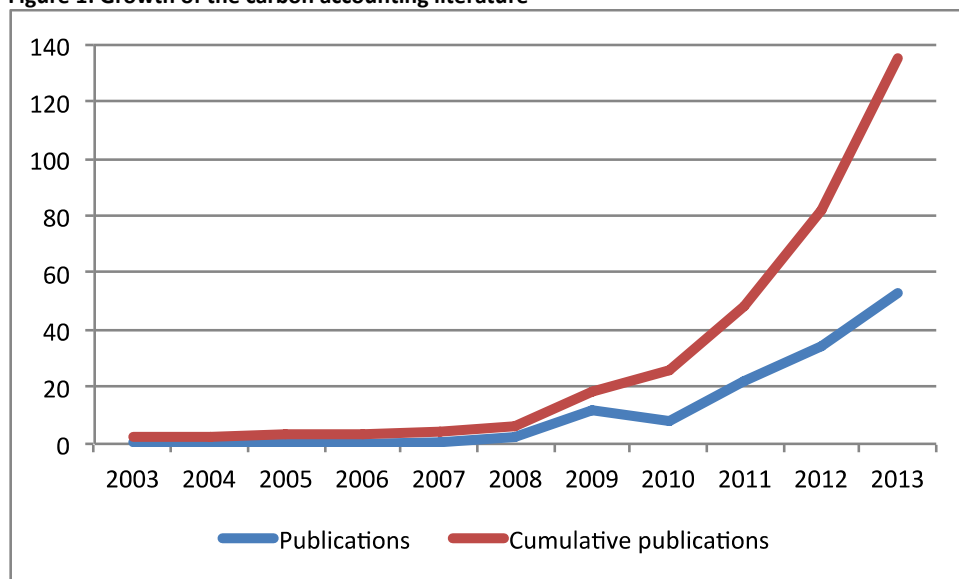
In JAPCEA, Zhang-Debreceeny, Kaidonis, and Moerman (2009) criticise the IASB approach to accounting for emission rights from an environmental ethics standpoint, similar to earlier critiques put forward by Milne (1996), Gibson (1996) and Lehman (1996) in response to the proposal by Wambsganss and Sanford (1996) for financial accounting of sulphur dioxide allowances in the SO₂ trading scheme in the US. The authors critique the definition of emission rights as an asset, arguing that from an environmental ethics perspective, humans have a responsibility to reduce emissions, which is inconsistent with the notion of a right to emit. They also object to defining emission rights as a liability, as this ‘entitles’ the firm to emit.

3.5. Carbon accounting education

De Aguiar and Fearfull (2010) propose using carbon disclosure to “spearhead emancipation from superficial educational accounting practices” (64), based on the premise that understanding corporate contributions to climate change is currently insufficiently covered within accounting, business and management curricula. Studying carbon disclosure, they argue, has four benefits: first, creating awareness of climate change; second, exposing students to critical accounting; third, developing an understanding of different types of accounting; and fourth, opening minds to the possibility of alternative corporate responses to climate change. The authors provide a practical example of carbon disclosure checklists that can be used as a pedagogical tool to achieve these objectives.

4. Observations and conclusions

The SEA literature on carbon accounting is surprisingly large, rich and varied. It has developed extremely rapidly, with cumulative publications tripling in one year (2009) compared to all previous years, and continuing to grow at an average of 66% per annum thereafter. This is illustrated in Figure 1, which includes for 2013 a further 46 papers which were published or in press after the review date of April 2013 (43 in JCP, two in CPA and one in AF). This is comparable to the rapid growth rate of the EMA literature in the early 1990s, which doubled in 1991 relative to all previous years and then grew by around 46% per annum for the next decade (Schaltegger and Zvezdov 2011), indicating that carbon accounting is likewise a young discipline with considerable growth potential.

Figure 1: Growth of the carbon accounting literature

The dominance of JCP by volume of publications is striking. Nevertheless, even if JCP is excluded from the scope of the review, cumulative publications quadruple in 2009 and grow at an average of 40% per annum thereafter, demonstrating that this is not a single-journal phenomenon. Perhaps a more relevant question is whether the key lessons about methodological uncertainty arising from the carbon management accounting literature in JCP are being taken into account by those working on carbon disclosure and carbon financial accounting, which implicitly rely on carbon management accounting data.

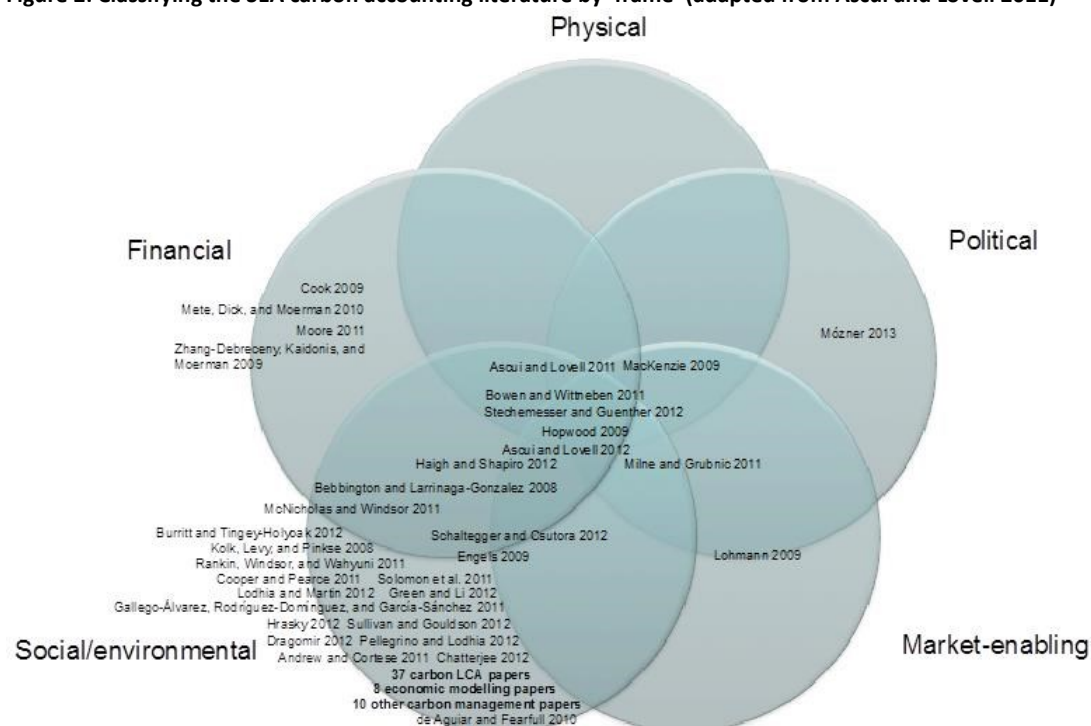
A tremendously encouraging sign is the large number of researchers who are involved (over 220 individuals in the papers covered by this review). Remarkably, no single researcher has more than two papers in this sample (while it must be acknowledged that several have published further papers on carbon accounting outside the scope of the review). This extensive and evenly distributed participation can be contrasted with observations made of the SEA research community more generally (Mathews 1997, 503; Parker 2005, 843). There is substantial evidence of collaboration, with the majority of papers involving two or more co-authors. These are, again, positive signs that despite the field being young, it has wide participation already, and therefore the potential to expand rapidly as these pioneering researchers consolidate their work, and further researchers join in.

The rise of carbon accounting in the SEA literature will no doubt be counted as further evidence of increasing emphasis on environmental, rather than social, accounting (Mathews 1997; Gray 2002; Owen 2008; Parker 2005; Parker 2011). However, this could be too hasty a conclusion. Global climate change resulting from rising greenhouse gas emissions has critical social implications: it will have vastly disproportionate impacts on the poorest sections of society, mainly in developing countries (IPCC 2007), it raises significant intergenerational equity issues, and the question of who is responsible for climate change has major political and potentially socially transformative implications. Carbon accounting approaches are deeply implicated in this responsibility question, and alternatives to the dominant paradigm of point-of-emission carbon accounting, such as allocating responsibility on the basis of consumption (Mózner 2013), fossil fuel extraction (Tickell 2008) or high emitting individuals, whether in developed or developing countries (Chakravarty et al. 2009) should be explored by SEA researchers as much for their social as their environmental implications. The international response to climate change already drives significant financial transfers from

developed to developing countries (UNFCCC 2008; UNFCCC 2011), which developed countries have promised to raise to \$100 billion/year by 2020 (UNFCCC 2009). Measuring such 'climate finance' is extremely challenging (Buchner, Brown, and Corfee-Morlot 2011) and should also be a fruitful area for carbon accounting researchers in the coming years. In short, carbon accounting should be regarded as a sustainability accounting issue (Bebbington 1997), with equally important social and environmental dimensions, rather than a purely environmental accounting matter.

In terms of the coverage of carbon accounting in practice, it is interesting to compare the focus of the papers in this sample with the five frames identified by Ascui and Lovell (2011): physical, national, market-enabling, financial and social/environmental carbon accounting. Figure 2 provides a subjective classification of the reviewed papers according to the frame of main emphasis. It is immediately apparent that most of the literature concerns the 'social/environmental' framing of carbon accounting, mainly concerned with either internal carbon management accounting, or external carbon disclosure, and with organisations or their products and supply chains as the main unit of analysis. This should not be surprising, given that the scope of the review was limited to carbon accounting in the SEA literature. However, it does suggest considerable scope for SEA researchers interested in carbon accounting to broaden their engagement with other forms of carbon accounting.

Figure 2: Classifying the SEA carbon accounting literature by 'frame' (adapted from Ascui and Lovell 2011)



The second most popular area (if we ignore the central cluster of multiple-frame papers) is, also unsurprisingly, carbon financial accounting. This is an area where accountancy researchers can bring undisputed expertise to help develop practical solutions in an area where the lack of an accepted international standard creates significant differences in financial reporting between companies (PricewaterhouseCoopers and IETA 2007; Deloitte 2007; KPMG 2008; Cook 2009; MacKenzie 2009; Lovell et al. 2010) and which is showing signs of being taken seriously once again by standard-setters (Autorité des normes comptables 2012; EFRAG 2012). There is equally a role for SEA researchers to help

understand and theorise the standard-setting process, the role of different agents within this, and the implications for other areas of social and environmental accounting.

However, accountancy researchers should engage more deeply with the 'market-enabling' frame of carbon accounting in order to ensure that proposals for financial accounting of carbon allowances and obligations, which arise as a consequence of carbon markets, reflect the nuances of these highly original, experimental markets, rather than being conditioned only by pre-existing accounting classifications of similar items (the 'finitist' approach discussed by MacKenzie [2009]). There is tremendous potential for misunderstanding at the intersections of different frames of carbon accounting – the 'collisions' referred to by Ascui and Lovell (2011) – even at the simplest level through the use by different communities of the same terminology for different things. For instance, Mete, Dick, and Moerman (2010) point out that from a financial accounting standards perspective, the term "allowance" is generally equated with a "provision", or a "liability of uncertain timing or amount" (IAS 37). This could not be further from the meaning associated with the term in carbon markets such as the EU ETS, where "The total of all these allowances... represents the overall limit on emissions *allowed* by the scheme." (European Commission 2000, 7–8, my emphasis). Further semantic confusion is generated by the use of the term 'permit' within the EU ETS, as a legal instrument to bring specified installations within the scope of the regulation, as distinct from allowances which must be surrendered for every tonne of carbon dioxide (equivalent) emitted. Confusion arises because the term 'permit' can be synonymous with 'allowance' in the more general emissions trading literature. Likewise, much heat and little light has been generated by the multiple meanings associated with the term 'rights', also often a synonym for allowances. Although commonly an allowance is thought of as conferring a right to emit greenhouse gases, a recent UK Court of Appeal judgement in the case *Armstrong DLW GmbH v Winnington Networks Ltd* is instructive in that it argues more subtly that EU ETS allowances are *not* rights to emit greenhouse gases, but rather rights to exemption from a fine or penalty for emitting greenhouse gases.² Such nuances should provide fertile material for further SEA research in carbon financial accounting.

Leaving aside the financial accounting implications of carbon markets, the relative shortage of SEA papers dealing with the specifics of 'market-enabling' carbon accounting is striking. 'Market-enabling' carbon accounting covers a multitude of calculative practices by which physical emissions of greenhouse gases, reductions in emissions against a hypothetical baseline, and increases in carbon stored in sinks such as forests are measured, monitored, reported and audited, resulting in the creation of allowances, offsets or carbon credits which are traded and used in carbon markets. There is vast scope for research here, for example into the controversies associated with carbon offsetting, additionality, counterfactual baselines, perverse incentives, carbon leakage, double-counting and double-crediting, permanence and accounting for reversals of carbon storage (Marland, Fruit, and Sedjo 2001). These accounting practices underpin considerable financial flows, principally in the Kyoto Protocol Clean Development Mechanism (CDM) and the voluntary carbon offsetting market, which accounted for transactions worth over US\$25 billion and US\$572 million respectively in 2011 (Kossoy and Guignon 2012; Peters-Stanley and Hamilton 2012). Much academic research has been published in this area, but it is more likely to be found in the pages of journals such as *Climate Policy* (e.g. Sedjo and Marland 2003; Locatelli and Pedroni 2004; Subak 2003) or *Global Environmental Politics* (e.g. Newell and Bumpus 2012) than in the SEA journals selected as the scope for this review. This seems to be an area touching very closely on SEA expertise, where there is a need for more SEA "witnesses" of the kind both called for and demonstrated by MacKenzie (2009).

The physical and political frames of carbon accounting likewise need witnesses. Possible areas for further research include greater scrutiny of national accounts under the UNFCCC and Kyoto Protocol (of the kind provided by Milne and Grubnic [2011] and Milne, Ball, and Mason [2010]), examining the data sources, assumptions, methods and uncertainties in these accounts, as well as alternative accounting frameworks (such as that explored by Mózner [2013]). The issue of Global Warming Potentials used to commensurate different greenhouse gases needs further attention given the political and practical consequences of their application, including consideration of the implications of alternative assumptions (such as shorter time-horizons, which would suggest we should focus vastly more resources on reducing methane emissions) as well as the viability of alternative metrics (Lashof and Ahuja 1990; Shine et al. 2005; Plattner et al. 2009). Most other forms of carbon accounting depend to some degree on (usually unquestioned) acceptance of some underlying physical carbon accounting, and these interfaces between frames deserve particular critical inquiry. Examples might include questioning the use of bottom-up physical monitoring with flux towers combined with atmospheric modelling to verify top-down national accounts (Bergameschi 2007; Ciais et al. 2010); the role of first order decay models in accounting for hypothetical methane abatement from a range of different types of CDM project (M. Lazarus et al. 2010); or the use of allometric equations in estimating various pools of carbon stored in soils and forests (IPCC 2003).

Many of the papers reviewed here have called for greater interdisciplinary cooperation, for example between accountants, natural scientists and engineers, as well as between academic researchers and practitioners. All of these disciplines and communities are in fact already well represented in the present sample of papers. However, there is not yet sufficient evidence of them working together. For example, nearly all of the natural scientists and engineers appear only in the pages of JCP, focussing on product or process LCA. Accountants and other social scientists tend to focus on corporate carbon accounting. This leads to blind spots in the literature, particularly around technically complex areas such as biogenic carbon accounting, where relatively few social scientists (e.g. [Lohmann 2009]) have engaged with the rich seam of research by natural scientists on this controversial topic (Maclaren 1999; Marland, Fruit, and Sedjo 2001; Sedjo and Marland 2003; Reijnders and Huijbregts 2003; Locatelli and Pedroni 2004; Bringezu et al. 2009; Ponsioen and Blonk 2012; Petersen et al. 2013). Perhaps this is because biogenic carbon accounting could be regarded as more of a government responsibility than a corporate one. Nevertheless, with forest footprint reporting being brought within the scope of the CDP from 2013, corporate responsibility for forest carbon accounting is now clearly on the agenda for investors.³ Mathews' (1997, 501) comment on the lack of involvement of accountants in environmental audit at the time seems still to be relevant: "Once again the reluctance of accountants to move away from traditional attitudes and paradigms is limiting the advance of the discipline into new fields of endeavour."

In conclusion, carbon accounting is undoubtedly already a topic of considerable interest and critical attention within the SEA literature. The number of researchers involved, and extremely rapid increase in publications, both point to a fast developing field with significant future potential. There is already a good spread between critical, philosophical or normative discussions and empirical studies, with a healthy set of papers on carbon management accounting, carbon disclosure and carbon financial accounting, while carbon auditing and education also make an important appearance. Nevertheless, when compared with the wide scope of carbon accounting in practice, it appears that the SEA literature on carbon accounting has largely focussed on the social/environmental and financial framings of carbon accounting, displaying less engagement with market-enabling, physical and political

framings. The tendency to focus on *corporate* carbon accounting in the SEA literature may reflect upon the SEA 'project' more generally, and its preoccupation with the corporation as the accounting entity (Lehman 1999). Despite Gray's (2002, 692) observation that social accounting had "shaken off" the "shackles" of conventional accounting in favour of representing conventional accounting as a constrained sub-set of social accounting, perhaps the discipline's origin in a sense of dissatisfaction with conventional accounting practices (Bebbington 1997), while emancipatory in impetus, nevertheless still exerts some constraint on imagining alternative accountings. Carbon accounting offers an opportunity to critique existing accountings for a wide variety of accounting entities, some of which have nothing to do with the corporation, as well as to imagine new alternatives, particularly at the frontiers and collision zones between different frames (Ascui and Lovell 2011). It is therefore to be hoped that carbon accounting could itself be emancipatory: attracting new researchers into the SEA field, encouraging greater interdisciplinary cooperation and mutual learning, offering tremendous opportunities for engagement with practice and education, and helping to imagine new accountings free from the shackles of conventional accounting.

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³ See <https://www.cdproject.net/en-US/Programmes/Pages/forests.aspx> (accessed 1 April 2013).

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