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Making carbon count: The role of carbon accounting in carbon management and markets

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Abstract

Society's efforts to 'manage' the problem of human-induced climate change – for example through setting targets, tracking progress, imposing sanctions and incentives, and creating markets in emission rights and offsets – have given rise to numerous calculation, measurement, attribution, monitoring, reporting and verification challenges, which are being addressed by many different communities (including scientists, governments, businesses and accountants) in many different ways. Carbon accounting – this diverse and ever-expanding assemblage of calculative practices – is a rapidly evolving phenomenon, which has only recently become a subject of academic accountancy-related research. This thesis explores what carbon accounting means, who it involves, and how different communities define and lay claim to competence in the field. It also examines, through case studies on the emergence of the Climate Disclosure Standards Board and the controversies around generating tradable carbon offsets from forestry projects in the UK, the immense technical, cognitive, social and political work required to make carbon measurable, commensurable and thereby amenable to various forms of management.

The thesis contributes to both conceptual and practical understanding of carbon accounting as an emerging field of study. Bringing together a wide range of empirical examples of different types of carbon accounting practices, it proposes a unique definition of carbon accounting which expands the horizons of the field. It provides a conceptual basis for making sense of carbon accounting by considering it not as a unitary phenomenon but rather as a set of overlapping frames, each associated with different communities of practice. It shows that competence in carbon accounting is contested, particularly where these frames overlap, and that boundary organisations are emerging that offer the opportunity to negotiate such tensions and lead to more productive policy-making. Finally, it makes the case that engagement with the detail of the 'nuts and bolts' of carbon accounting is essential, as these apparently technical details can have major implications for the effectiveness of society's response to climate change, and it is only by opening them up to rigorous scrutiny that we can make progress, both conceptually and practically.

Declaration

I declare:

(a) that the thesis has been composed by myself, and

(b) that the work is my own, or, where work has formed part of jointly-authored publications, that I have made a substantial contribution to the work, such contribution being clearly indicated, and

(c) that the work has not been submitted for any other degree or professional qualification.

Signed:

Francisco Ascui

Date:

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I would like to thank all those who have read and commented on this thesis, in part or in its entirety, in particular Heather Lovell, Craig Mackenzie, Bill Rees, Matthew Brander and Bryan Lovell. I am also grateful for the comments and suggestions from the editors and anonymous reviewers of parts of this thesis which have been published as papers in special issues of *Accounting, Auditing and Accountability Journal*, *Journal of Cleaner Production* and *Social and Environmental Accountability Journal* (Ascui & Lovell 2011; Ascui & Lovell 2012; Ascui 2014). Thanks are also due to the many practitioners of carbon accounting with whom I have worked and discussed technical issues over the years. I would also like to thank my internal and external examiners for agreeing to carry out these roles, and to acknowledge the support of the UK Economic and Social Research Council (ESRC) through a PhD studentship under the UK Centre for Climate Change Economics and Policy from September 2008 to March 2009, and the University of Edinburgh for a Staff Postgraduate Scholarship from January 2010 to completion. Above all, my thanks go to my wife and children for their generosity in sharing their lives with this thesis for the past several years.

Acronyms

AAAJ	*Accounting, Auditing and Accountability Journal*
AAU	Assigned Amount Unit (unit issued under IET)
ACCA	Association of Chartered Certified Accountants
AES	Applied Energy Services (a US energy company)
AF	*Accounting Forum*
AFOLU	Agriculture, Forestry and Other Land Use
AOS	*Accounting, Organizations and Society*
ARD	Afforestation, Reforestation and Deforestation
C	Carbon
CAR	Climate Action Reserve
CCAR	California Climate Action Registry
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CDSB	Climate Disclosure Standards Board
CER	Certified Emission Reduction (unit issued under the CDM)
CFI	Carbon Farming Initiative
CH_4	Methane
CHP	Combined Heat and Power
CIMA	Chartered Institute of Management Accountants
CMIA	Climate Markets and Investors Association
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COP	Conference of Parties (to the UNFCCC)
CPA	*Critical Perspectives on Accounting*
CRC	Carbon Reduction Commitment
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
EAR	*European Accounting Review*
EFRAG	European Financial Reporting Advisory Group
EMA	Environmental management accounting
ERU	Emission Reduction Unit (unit issued under JI)

ETG	Emissions Trading Group (UK organisation)
ETS	Emissions trading scheme
EU ETS	European Union Emissions Trading System
EUA	EU Allowance (unit issued under EU ETS)
FASB	Financial Accounting Standards Board
GAAP	Generally Accepted Accounting Principles
GHG	Greenhouse gas
GRI	Global Reporting Initiative
Gt	Gigatonne (one billion tonnes)
GWP	Global Warming Potential
ha	Hectare
HFCs	Hydrofluorocarbons
IASB	International Accounting Standards Board
ICAEW	The Institute of Chartered Accountants in England and Wales
IET	International Emissions Trading (under the Kyoto Protocol)
IETA	International Emissions Trading Association
IFRIC	International Financial Reporting Interpretations Committee
IPCC	Intergovernmental Panel on Climate Change
JAPCEA	*Journal of the Asia-Pacific Centre for Environmental Accountability*
JCP	*Journal of Cleaner Production*
JI	Joint Implementation
KP	Kyoto Protocol
LCA	Life cycle assessment
LUCS	Land Use and Carbon Sequestration (model developed by WRI)
LULUCF	Land Use, Land-Use Change and Forestry
Mt	Megatonne (one million tonnes)
MW	Megawatt (one million watts)
N_2O	Nitrous oxide
NAP	National Allocation Plan
NF_3	Nitrogen trifluoride
NGAS	New South Wales Greenhouse Gas Abatement Scheme
NGO	Non-governmental Organisation
NOx	Oxides of nitrogen

NSW	New South Wales
OTC	Over-the-counter
PES	Payments for ecosystem services
PFCs	Perfluorocarbons
QAS	Quality Assurance Scheme
REDD	Reducing Emissions from Deforestation and Degradation
RGGI	Regional Greenhouse Gas Initiative
RMU	Removal Unit
SEA	Social and environmental accounting
SEAJ	*Social and Environmental Accountability Journal*
SF_6	Sulphur hexafluoride
SGS	Société Générale de Surveillance
SO_2	Sulphur dioxide
t	Tonne (metric)
TCNC	The CarbonNeutral Company
UK ETS	UK Emissions Trading Scheme
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
WBCSD	World Business Council for Sustainable Development
WCU	Woodland Carbon Unit
WRI	World Resources Institute

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1. Introduction

This thesis is about carbon accounting – an exploration of what it is, who it involves, and how it is done. Society's efforts to 'manage' the problem of human-induced climate change – for example through setting targets, tracking progress, imposing sanctions and incentives, and creating markets in emission rights and offsets – have given rise to numerous calculation, measurement, attribution, monitoring, reporting and verification challenges, which are being addressed by many different communities (including scientists, governments, businesses and accountants) in many different ways. Carbon accounting – this diverse and ever-expanding assemblage of calculative practices (Miller 1998; P. Miller 2001) – is a rapidly evolving phenomenon, which has only recently become a subject of academic accountancy-related research (see chapter 4).

Carbon accounting is important because it is a fundamental enabler of virtually all of society's responses to the problem of human-induced climate change. Whilst I believe that the 'managerialist turn' as a response to the environment can, and should, be challenged (see for example Gray & Bebbington 2000), it is inarguable that this approach is currently dominant, at least in international, national and corporate responses to climate change. For example, the United Nations Framework Convention on Climate Change (UNFCCC) sets an objective ("stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system") and then establishes a measurement system as its first commitment for all Parties ("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…") (United Nations 1992, Articles 2 and 4.1[a]). The Kyoto Protocol sets "quantified emission limitation and reduction commitments" for each developed country Party, with a subtly different measurement and reporting framework (United Nations 1998, Article 3.1). The European Union (EU) has pioneered the world's largest carbon market, the EU Emissions Trading System (EU ETS), which turns previously unrestricted emissions of around two billion tonnes of carbon dioxide equivalent per year into a new market for tradable allowances, worth US$148 billion in 2011 (Kossoy & Guignon 2012). A wide variety of other carbon pricing mechanisms have been set up in many countries, each relying on a newly created apparatus of accountability, measurement, commensuration and commodification of greenhouse gas emissions, emission reductions and removals of greenhouse gases from the atmosphere (Kossoy et al. 2013). The UK has gone farther than most other nations in establishing long-term targets and a

procedure for setting a legally-binding series of 5-year carbon budgets under the Climate Change Act 2008.[1]

The mantra of "what gets measured gets managed"[2] is routinely invoked as a primary reason for corporations to undertake carbon accounting (WBCSD & WRI 2004; Defra 2009b; Innovest 2007; Defra 2010). In 2012, over 4,000 of the world's largest companies reported on a voluntary basis to the Carbon Disclosure Project (CDP), and in late 2013, reporting on greenhouse gas emissions became mandatory under the Companies Act 2006 for all listed UK companies.[3] Whether we like it or not, many powerful actors see climate change as a problem to be managed by setting targets, tracking progress, imposing sanctions and incentives according to performance, and generally bringing the sphere of 'the environment' (in this case, the global atmosphere) within the ambit of a managerialist and neo-liberal form of political and economic governance. "Carbon is the new 21st-century performance metric," observe Newton et al. (2012, p.153).

Despite this, carbon accounting is easily overlooked. It is a new and complex activity, practised by relatively small numbers of specialists, according to an ever-growing array of complicated rules and procedures which are set by a handful of both formally and informally appointed regulators. Yet such is the economic and environmental importance of the carbon management activities that carbon accounting enables, that small and apparently 'technical' choices, which are most likely invisible to the wider community, can have very significant consequences. For example, Fogel (2005) discusses the debate between scientists involved in production of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Land Use, Land Use Change and Forestry in 2000, observing the "surprisingly large quantitative implications that decisions on these seemingly 'technical' definitional issues would have. Depending on the combinations used, industrialized countries could be faced with debits of about 849 megatons of carbon per year or credits of 483 megatons [of] carbon per year…" (p.205). In a similar vein, Gielen et al. (2002, p.591) provide an alternative

[1] See https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets (accessed 6 November 2013).

[2] This saying is often attributed to Peter Drucker, but I have been unable to source any reliable evidence for this. It is also sometimes attributed to Willcocks & Lester (1996), but even there is it is described as a 'mantra', and earlier references can be found. A wordier exposition of the same concept can be traced back to Lord Kelvin in an 1883 lecture (see http://athinkingperson.com/2012/12/02/who-said-what-gets-measured-gets-managed/, accessed 7 November 2013). I conclude it is an un-attributable saying in widespread use.

[3] See https://www.cdproject.net/en-US/Results/Pages/overview.aspx and https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance (accessed 6 November 2013).

account of Japan's emissions from the petrochemicals sector, arguing that "the current Japanese national GHG account overestimates carbon storage by 23 Mt (an overestimation of 20%, 1.9% of the Japanese CO_2 emissions)" – certainly significant in the context of Japan's Kyoto Protocol target of a 6% reduction on 1990 levels by 2008-2012. In January 2011, a single vote in the European Union (EU) Climate Change Committee (made up of bureaucrats and technical experts nominated by EU Member States) effectively crushed global demand for millions of carbon credits from industrial gas destruction projects – credits which until then had generated substantial earnings for certain companies, such as Gujarat Fluorochemicals Ltd, alleged to have earned €66 million in 2007 from sales of these credits alone.[4]

This thesis aims to open carbon accounting up to rigorous scrutiny, in the hope that doing so may help it to become more effective at managing the problem of human-induced climate change, and shed light on our understanding of how new social and environmental accounting practices are conceptualised and evolve over time. It has been written at a time when carbon accounting is just beginning to be researched by management and accounting academics, and is thus exploratory in outlook, rather than seeking to falsify a particular hypothesis or test a given theoretical framework. Indeed, there were virtually no papers at all on carbon accounting in the academic accountancy literature when I started my research in September 2008, although the growth in research publications since then – to which I have also contributed – has been exponential (see chapter 4).

1.1. Research questions

I deliberately want to evoke multiple interpretations of the word "count" in my title ("Making carbon count"), insofar as I hope to cast some light on the ways in which carbon (as shorthand for carbon dioxide, standing in for greenhouse gases generally) is or can be made to *matter*, to signify and be significant, of greater consequence, of account, to include what might otherwise be excluded, and to become more reliable and dependable, something we can 'count on'.

The main questions motivating this research have to do with how carbon accounting is conceptualised and practised, and are therefore both theoretical and empirical in nature:

1. What is carbon accounting? How is it understood in different contexts?

[4] See http://carbonmarketwatch.org/eu-member-states-gearing-up-for-crucial-vote-on-fake-carbon-offsets-will-corporate-interests-win-the-day/ (accessed 7 November 2013).

2. Who are the principal communities involved in carbon accounting, and how do these communities interact?
3. How might an improved understanding of carbon accounting help to resolve accounting-related problems in carbon management and markets?

There is some overlap between the questions, which is reflected in overlaps between chapters. However, generally speaking, question 1 is addressed in chapter 4, which reviews how carbon accounting has developed as a topic of academic research, and chapters 5 and 6, which explore the social, institutional and historical contexts in which carbon accounting has developed as a practice. Question 2 is the subject of chapter 7 and question 3 is dealt with most intensively in chapter 8, but also via numerous examples and discussion throughout the thesis. Chapters 2 and 3 provide the background methodology and theory that has been used to answer these questions.

Throughout the thesis I use the term 'practice' in the sense of "the mundane tools and instruments that allow one to calculate and intervene… in the world, and in the lives of others" (Miller 2008, p.53).

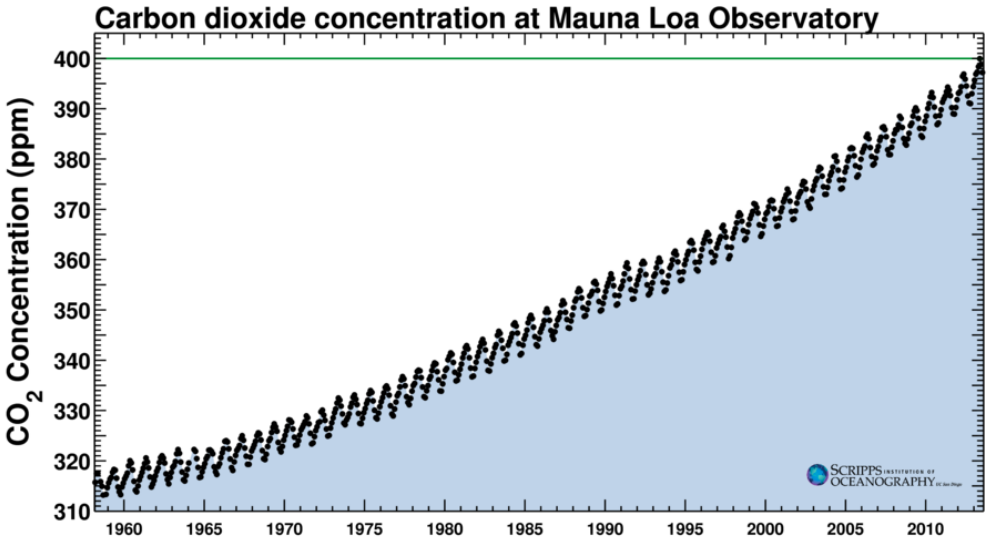
1.2. Background – why carbon accounting matters

The French scientist Joseph Fourier is credited with being the first to propose, in the 1820s, that the Earth's atmosphere could play a role in preventing heat from escaping into space, thus keeping the planet significantly warmer than it would be in the absence of an atmosphere. He used the analogy of a box covered with a pane of glass to explain his intuition, which eventually gave rise to the widely used term 'greenhouse effect'. The actual physics of how the atmosphere traps heat was only later understood from the experimental work of John Tyndall in 1859, which demonstrated that certain trace gases in the atmosphere – principally water vapour and carbon dioxide – were effectively opaque to certain wavelengths of infra-red (heat) radiation. This understanding allowed the Swedish chemist Svante Arrhenius (1896) to provide a first estimate of the global warming that would result from a doubling of carbon dioxide levels in the atmosphere (5.7°C, surprisingly close to the best modern-day estimate of 1.5-4.5°C – IPCC 2013, p.14). Thus the foundations for the modern science of global climate change were laid down more than a century ago (for an excellent history of the development of climate science see Weart 2003).

The work of these nineteenth-century scientists also provides the fundamental basis for understanding the importance and relevance of the concept of carbon accounting that is the subject of this thesis. The fact that emissions of carbon dioxide and other 'greenhouse' gases cause warming of the atmosphere, and that this is a global, cumulative effect rather than localised and episodic, makes the measurement, attribution and accountability for these emissions a matter of global significance. Unlike most other environmental externalities, greenhouse gas emissions (at their typical low concentrations) have negligible local impact, whereas their global impact is relatively well understood, opening up the possibility, at least, of standardised international accounting and consistent accountability.

Changing the global climate is not the only way in which humanity is thought to be at risk of (or already) exceeding planetary boundaries proposed to define a "safe operating space for humanity" (Rockström et al. 2009, p.472). For example, the current rate of biodiversity loss is estimated to be 100-1,000 times the normal background rate, threatening the extinction of up to 30% of all mammal, bird and amphibian species by 2100, and human agricultural activity is believed to be already exceeding safe thresholds for perturbing the global nitrogen cycle (Rockström et al. 2009, p.474). Climate change is nevertheless one of the most pressing of these global threats, not least because of its deleterious effects on other planetary boundaries: for example, climate change is projected to be a key driver of future biodiversity loss, and higher atmospheric concentrations of carbon dioxide lead to ocean acidification (Barnosky et al. 2012). In addition, it can be argued that no other environmental externality is quite as inextricably linked with modern economic activity as carbon dioxide emissions, and hence no other externality presents quite as intractable a mitigation challenge to modern society. Since the Industrial Revolution, economic growth has gone hand-in-hand with increased energy consumption, largely derived from fossil fuels, driving a cumulative injection into the atmosphere of approximately 555 billion tonnes of carbon (GtC) from 1750 to 2011 (IPCC 2013, p.10; Schmidt & Archer 2009). As a result, concentrations of carbon dioxide in the atmosphere (shown in Figure 1 below) reached 400 parts per million (ppm) in 2013 – a 43% increase on the pre-industrial 'equilibrium' level of around 280ppm (Kunzig 2013).

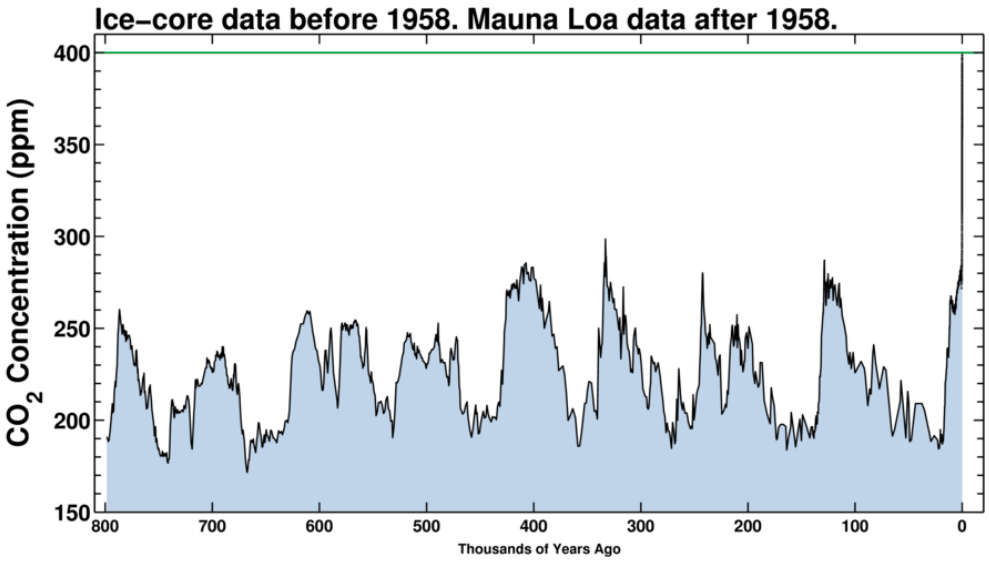
Figure 1: The 'Keeling Curve' – direct atmospheric carbon dioxide measurements from Mauna Loa observatory



Source: http://keelingcurve.ucsd.edu/ (accessed 9 August 2013).

This is not just unprecedented on an ordinary human time-scale: the last time carbon dioxide levels are believed to have been this high was 2.6-5.3 million years ago, during the Pliocene epoch (Figure 2 provides an illustration of the last 800,000 years, for which carbon dioxide concentrations can be directly measured from bubbles of air trapped in ice core samples). What makes this all the more unprecedented is the speed with which it is occurring: nearly two-thirds (350 GtC) of the post-industrial 'pulse' of carbon to the atmosphere has been released in the last 50 years alone (Ballantyne et al. 2012). Global emissions of carbon dioxide from fossil fuels have increased at an average of 3.1% per year since 2000 (Peters, Andrew, et al. 2012), with the financial crisis of 2008-2009 causing only a single-year deviation, already cancelled out by above-average growth in 2010 (Peters, Marland, et al. 2012).

Figure 2: Direct atmospheric measurements of carbon dioxide combined with ice core data

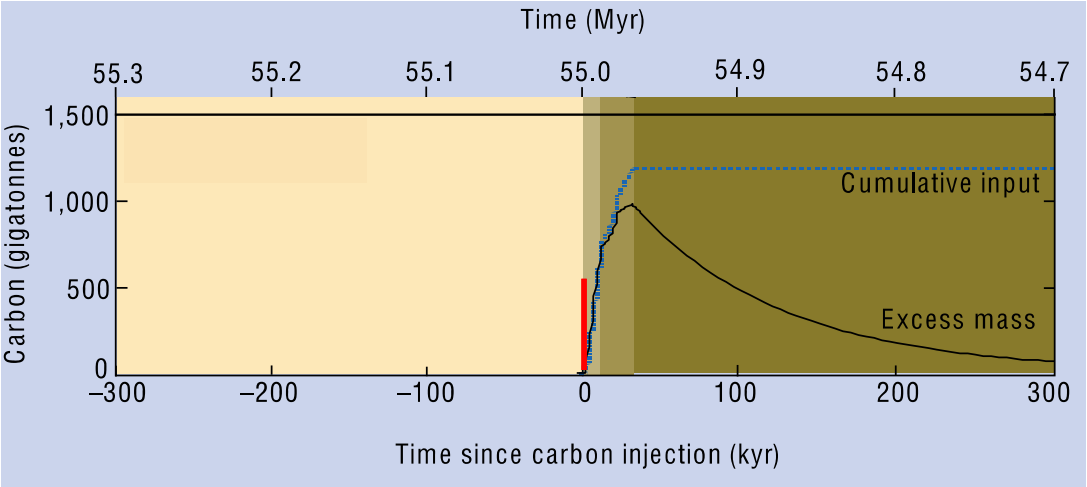


Source: http://keelingcurve.ucsd.edu/ (accessed 9 August 2013).

The last well-known event of similar magnitude, the Paleocene-Eocene Thermal Maximum (PETM) of 55 million years ago, involved an injection of around 1,000 GtC into the atmosphere over a period of around 10,000 years[5], causing the oceans to warm by 5-7°C and resulting in extinction of 35-50% of deep-ocean organisms – their only global extinction of the last 75 million years (Norris & Rohl 1999; Dickens 1999). At the same time, surface temperatures across the globe rose by 6-8°C (Dickens 2004), likewise accompanied by extinctions of previously characteristic land-based species, followed by the sudden appearance of three entirely new orders of mammals. To put this in context, we have already reproduced around half of the input that resulted in this evolutionarily significant past event, and at current emission rates we will complete the remaining half within the next 50 years.

[5] The cause of this carbon injection is uncertain, but likely suspects include the melting of methane hydrates from shallow marine sediments, perhaps triggered by volcanic activity (Svensen et al. 2004) or the release of methane from thawing terrestrial permafrost (DeConto et al. 2012). Both of these massive reservoirs of carbon are considered to be at risk of destabilization in future due to global warming (Whiteman et al. 2013; Schuur et al. 2013).

Figure 3: The Paleocene-Eocene Thermal Maximum compared with current release of carbon to the atmosphere



Source: Adapted by the author from Dickens (1999), after B. Lovell (2010). The superimposed solid red line illustrates, for comparison, the approximate magnitude and rate of the current release of 555 GtC since 1750 (IPCC 2013, p.10).

The natural science perspective on climate change is relevant because it is our scientific understanding of the relationship between fossil fuel emissions and global climate change, and of the significance of the impacts of global climate change, that drives all further concerns with carbon accounting. Without this, while we might still be concerned with various local or regional pollution effects associated with fossil fuel combustion (e.g. particulate emissions, acid rain from sulphur dioxide emissions, mercury emissions, etc.) we would not face such a uniquely global, and uniquely challenging, problem.

1.3. Methodology

The thesis draws on a variety of research methods, including analysis of documentary sources, participant observation and case studies. My overall approach is loosely based on grounded theory, aiming to develop new understanding based on iterative interpretation of empirical data, as opposed to hypothesis testing (see chapter 2 for further details).

It is appropriate at this point to acknowledge the important role that my own previous and on-going practitioner experience of carbon accounting has played in informing the subject, direction, empirical content and interpretation of my research. I carried out various forms of carbon accounting for ten years before starting my PhD research, and continued in various practitioner roles during the next five years, sometimes alongside but at other times incorporating this within the scope of my research. While this might violate the positivist

conception of the researcher as objective and independent from the subject of analysis, my research is not grounded in the positivist paradigm. Rather, from an interpretive or social constructionist perspective, my involvement in the practices that I observe can be seen as an advantage in understanding what is effectively a relatively recent socially constructed practice. I acknowledge the potential for bias, for example in terms of perceiving or favouring only those forms of carbon accounting in which I have been personally involved, but point out that this is mitigated by the breadth and variety of my experience, the fact that my practitioner roles (e.g. as civil servant or consultant) have all relied on a reputation for both expertise and independence, and the high level of interactions that I have had with other practitioners in the field. In the end, I think the validity of my research findings comes down to whether they make sense, at very least to others involved in the field either as practitioners or academics, and hopefully also to others not yet involved. With that in mind, I have discussed my research with practitioners and academics at every opportunity, and much of the thesis has already been published, receiving critical feedback in the process. These publications are detailed in section 1.5 below.

This is also an appropriate point to acknowledge the debt that I owe to these many informants, as well as reviewers, advisors and research collaborators. In particular, with respect to the latter, given that parts of the thesis have been published as co-authored publications, I would like to acknowledge the contributions of my co-authors, and to define the extent to which the work in this thesis is my own.

Chapters 6 and 7, together with an earlier version of the expanded definition of carbon accounting in chapter 5, appear in two publications co-authored with Heather Lovell, who started working on carbon accounting at around the same time as I started my research for this PhD, in 2008. Over the period of collaboration on these two papers we were both Lecturers at the University of Edinburgh, in different Schools. Lovell's work, begun in 2008 under a Nuffield Foundation Fellowship 'Fungible Carbon' with Donald MacKenzie, concentrated for the first two years on what we came to call the 'financial' frame of carbon accounting (in Ascui & Lovell [2011]). Whilst I was aware of this form of carbon accounting, the salience of financial accounting in Lovell's research at the time, combined with my interests and past experience in what we eventually described as the physical, political, market-enabling and social/environmental frames of carbon accounting, helped to develop the concept of five key frames that underpins chapter 6 and Ascui & Lovell (2011). Later, after having an abstract for a paper on 'Carbon accounting and the construction of

competence' accepted for a special issue of the *Journal of Cleaner Production*, I invited Lovell to collaborate on what became Ascui & Lovell (2012). This benefited from incorporating some of my co-author's interview material and experience as a member of the Technical Working Group of the Climate Disclosure Standards Board (CDSB) alongside my own empirical material, as well as her suggestions for theoretical lenses. I have retained this empirical material, as published, in chapter 7, and acknowledge a more general debt in terms of her guidance towards several of the conceptual frameworks that have informed my work (discussed in the next section).

Chapter 8 is also informed by collaboration, in this case with Till Neeff with whom I wrote a report for the UK Forestry Commission on options for the development of a market for forest carbon in the UK (Ascui & Neeff 2013). However, this report was for a non-academic audience and I have made my own interpretation of the topic for the purposes of this thesis.

My own contribution to the above co-authored works is highlighted as follows:

- In all cases, I have only included material from co-authored work where I have been the lead author. In the case of the Forestry Commission project which informs part of chapter 8, I was formally the leader of the research team, in addition to lead author. As lead author, I have always taken final responsibility for the published text: any errors and omissions are therefore my own.
- Where practicable, I have not included material originally drafted by my co-authors. An exception is section 6.2.4 on the financial frame of carbon accounting in chapter 6, which was first drafted by Lovell, although the final text reflects further inputs from myself, both conceptually and textually. My co-author's contribution is acknowledged, both here and at the top of that chapter.
- The text of section 3 of Ascui & Lovell (2011), which introduces the concept of framing, was also first drafted by my co-author. Like the section on carbon financial accounting, the final text reflects substantial inputs from myself. I have provided my own discussion of framing in chapter 3 of this thesis, where the text reflects my own personal reading and understanding of the subject. Nevertheless, I acknowledge my co-author's contribution in terms of introducing me to several of the concepts and authors discussed in that chapter.
- My co-authors made other contributions to my work that are impossible to isolate or attribute in detail, including suggestions, corrections, encouragement and support, for

which I am very grateful. I am likewise grateful for similar contributions from a number of individuals who kindly read and commented on my work, including the anonymous reviewers of the papers submitted for publication.

In summary, I hope that my contribution is evident not only in individual chapters of the thesis, but also and perhaps more importantly in the thesis as a whole.

1.4. Approach to theory

As an exploratory study of an area in which there was, at least at the outset, very little academic research, finding suitable theoretical frameworks which could help explain or structure my understanding of the subject was not straightforward. Arguably, high levels of theorising would have been inappropriate in any case, given the nature of my topic, my approach to methodology and the lack of an established body of research in the area. "High levels of prior theorizing are indicative of an assumed material world (which exists distinct from the observers' projections and bias) which, despite empirical variety, has high levels of generality and order and has been well researched through previous studies" (Laughlin 1995, p.66). My research is situated towards the opposite end of the spectrum, where "the empirical detail is not mere confirmable or refutable "data" for some prior theory but… *becomes* the theory for this particular phenomena…" (Laughlin 1995, p.67). The generality of my findings is therefore limited. In the end, I have drawn on several theoretical frameworks from different disciplines to help make sense of the empirical material, whilst recognising that each of these provide only partial support and none can be considered a 'theory of carbon accounting'.

The theoretical frameworks I have drawn from include framing (drawn from its separate uses in the policy discourse and economic sociology literatures), commensuration (from sociology and accounting), epistemic communities (from international relations) and boundary-work (from the sociology of science). It may be asked why I have not made more use of theories more widely employed in the field of social and environmental accounting research, such as stakeholder theory, legitimacy theory or agency theory (Parker 2005). The short answer is that these theories typically have the organisation, usually in fact the corporation, as their unit of analysis, whereas my unit of analysis is a practice which can be applied at many levels and is certainly not limited to organisational or corporate boundaries or motivations. As I will show in chapter 5, the historical development of carbon accounting starts in the natural sciences and then crosses into policy and politics at the national level, as

well as carbon offsetting at the project level, only later becoming more prominent at the organisational level. As I am interested in the entirety of this trajectory, it is appropriate to consider more general theories drawn from the sociology of science, policy discourse and international relations, rather than more specific organisational theories. Nevertheless, I readily admit that these organisational theories have their place when it comes to investigating corporate carbon accounting and disclosure, and my review of the literature in chapter 4 shows that many other researchers have already begun to use them in this context.

1.5. Structure and summary of the thesis

Chapter 2 discusses my approach to research methodology, and the specific research methods used, including the role of participant observation, document analysis and case studies. My personal background in carbon accounting is explained, as this forms an important input to the empirical basis of the research. Chapter 3 discusses the theoretical frameworks that have informed the research, including the concepts of framing, commensuration, epistemic communities and boundary-work. These frameworks are not specific to carbon accounting, and have only recently been applied to the subject, in my own work and a small number of other contributions (principally Kolk et al. 2008; MacKenzie 2009; Lohmann 2009; Ascui & Lovell 2011; Ascui & Lovell 2012).

The next five chapters form the main original conceptual and empirical contribution of the thesis and are organised as follows. Chapter 4 reviews how carbon accounting has been researched in the social and environmental accounting (SEA) literature, as the most obvious disciplinary locus of academic interest in carbon accounting for this thesis, situated as it is within the accounting and finance subject area of a business school. As this chapter focuses on the SEA literature, it is limited (in common with several authoritative reviews of the SEA literature – Parker 2005; Owen 2008; Parker 2011) to a specific set of journals which are most closely associated with this literature. Whilst this excludes some relevant SEA literature published outside these journals, it includes five leading interdisciplinary accounting journals and three more specialised journals, which between them have published three special issues and two special sections on carbon accounting. It is complemented by chapter 5, which discusses a wider selection of literature, including grey literature, on carbon accounting from the perspective of practice, as well as other contributions from disciplines other than business and management.

Chapter 4 shows that carbon accounting has experienced an explosion of interest in the SEA literature, from a mere four papers pre-2008 (all in one journal and from a particular engineering-oriented life cycle assessment [LCA] perspective) to 89 papers at the time of conducting the review (April 2013). The literature can be divided into a set of papers *about* carbon accounting, and a much larger set of empirical studies *of* carbon accounting, which can be further sub-divided by subject matter into carbon management accounting, carbon disclosure and reporting, carbon financial accounting and carbon accounting education. A number of gaps or blind spots in the literature can be discerned. One such gap is a lack of truly interdisciplinary research: although many disciplinary perspectives are represented in the sample, nearly all of the natural scientists and engineers have published in just one journal (the *Journal of Cleaner Production*), usually with a focus on product or process LCA, whereas accountants and other social scientists tend to focus on corporate carbon accounting, mainly publishing in the other journals. Another notable gap lies in the shortage of papers dealing with the specifics of accounting in carbon markets. The remainder of this thesis makes a number of contributions toward addressing these gaps, setting the academic literature in the broader context of carbon accounting in practice (chapter 5), providing a conceptual framework for making sense of the many disciplinary perspectives or frames of carbon accounting (chapter 6), shedding light on some of the disciplinary and professional communities involved and how they interact (chapter 7), and providing a detailed case study, informed by an interdisciplinary approach, of a specific challenge in market-enabling carbon accounting (chapter 8). A paper based on chapter 4 has been published in a special issue of *Social and Environmental Accountability Journal* on carbon accounting (Ascui 2014).

Chapter 5 explores how carbon accounting has been defined and/or used in practice by different actors, drawing on a wide range of documentary sources as well as insights from my personal experience and participant observation. It shows that carbon accounting has a long history of practice in the physical sciences, originally under the guise of related terms such as ‘carbon budget’, before the first specific usage of the term ‘carbon accounting’ in the early 1990s, by forest scientists in relation to accounting for forestry and land use related emissions and removals of carbon dioxide from the atmosphere via carbon sequestration in biomass. This occurs in the context of a new wave of political action to take national responsibility for such emissions, and conversely a desire to ‘offset’ such responsibilities by claiming credit for removals within national boundaries. At around the same time, the extension of similar notions of responsibility and offsetting to the corporate level, at first on a completely voluntary basis, led by the US energy company AES, resulted in the first

transactions in what is now known as the voluntary carbon market. Over time, carbon markets have developed an elaborate set of calculative practices that in aggregate literally enable such markets to exist, defining and creating tradable emission rights and obligations. Finally, chapter 5 discusses the emergence of the practices of corporate and product carbon accounting, leading to popularisation of the term 'carbon footprint', showing that, like 'carbon accounting' more generally, the term is understood differently and ownership is contested by different communities. The chapter concludes that carbon accounting has been too narrowly defined by most commentators, who have tended to view it from particular disciplinary or professional perspectives, and proposes an expanded 'pick and mix' definition that covers a much wider range of practices than previously considered within the scope of carbon accounting.

Chapter 6 builds on this, proposing a conceptual framework for making sense of the many different understandings of carbon accounting from chapter 5, drawing on the concept of framing, itself derived from the broader field of discourse analysis (Hajer 1995). It proposes that carbon accounting in *practice* (as opposed to carbon accounting as an object of research, as discussed in chapter 4) can best be understood as a set of at least five major frames or perspectives, each of which has tended to operate in relative isolation, associated with different communities of practice, with particular disciplinary or professional allegiances. These five frames are here denoted as physical, political, market-enabling, financial, and social/environmental carbon accounting. It is argued that the connections, overlaps and discontinuities between frames have received insufficient critical attention, due to a lack of awareness of frames and the tendency for each frame to have its own institutions, normative practices and discourse, including academic literatures (as demonstrated in chapter 4, which can be understood as showing that the SEA literature concentrates on the social/environmental and financial frames of carbon accounting, with very little attention to physical, political and market-enabling carbon accounting). Moreover, 'collisions' between frames can be a cause of dysfunction with material consequences for carbon management and markets, some examples of which are discussed in chapter 6, with a more detailed example being analysed in chapter 8. It is argued that a more holistic understanding of carbon accounting could bring together knowledge and experience from multiple communities, enabling constructive 'frame-reflective' learning (Rein & Schön 1993) and policy change. A paper based on chapter 6 was published in a special issue of *Accounting, Auditing and Accountability Journal* on climate change, greenhouse gas accounting, auditing and accountability (Ascui & Lovell 2011).

Chapter 7 in turn builds on this conceptual framework, taking a closer look at some of the communities associated with different frames of carbon accounting, and the ways in which they define and lay claim to competence in this emerging field. The concepts of epistemic communities and boundary-work (introduced in chapter 3) are used to help explain the ways in which different communities involved in carbon accounting share a world-view which conditions or frames their understanding of a new topic such as carbon accounting, including perceptions of how it should be done (e.g. what are the relevant standards) and who is competent to do it (which encompasses both what are the relevant competences, and who is judged to have them). The chapter focuses on the role of accountants in carbon accounting. It is argued that while financial accountants have undisputed authority with respect to the financial frame of carbon accounting, when it comes to other forms of organisational carbon accounting, accountants share the field with a variety of both specialist and generalist consultancies, as well as internal functional managers. A typology of organisational carbon accounting is developed, building on earlier models (Bartolomeo et al. 2000; Burritt et al. 2002; Burritt et al. 2011), showing that even within the confines of the organisation as the subject of carbon accounting, a multitude of different practices may be relevant. Analysis of documentary sources and stakeholder interviews shows that accountancy professional organisations have engaged in strategic efforts to re-frame climate change as a subject of relevance to accountants, and progressively asserted their competence, in competition with the consultants and internal managers who had previously dominated organisational carbon accounting in practice. The case of the Climate Disclosure Standards Board (CDSB) is then explored, leading to the conclusion that this body provides an example of a boundary organisation that enables productive collaboration between communities of accountants and environmental NGOs, nevertheless arguing that this collaboration should not go unscrutinised, both because it may potentially exclude other viewpoints and communities, and because of the significant financial rewards that may be captured in future by those who can successfully claim competence in carbon accounting. A paper based on chapter 7 has been published in a special issue of the *Journal of Cleaner Production* on climate accounting and sustainability management (Ascui & Lovell 2012).

Chapter 8 presents a detailed case study exploring an instance where carbon accounting seems to be failing to deliver effective carbon management, through carbon markets in particular. The case examines the difficulties experienced by investors in UK forests in extracting value from the carbon sequestered in those forests. It explores the reasons for

policy inaction in this area, illustrating the immense technical, cognitive, social and political *work* that is required to make 'carbon' comprehensible, quantifiable, accountable and tradable – in short, commensurable – within carbon markets. It shows how technical debates about carbon accounting quickly become enmeshed in social power struggles and wider politics, and discusses the various ways in which commensuration becomes institutionalised, for example via standards and related infrastructure such as alliances and representative bodies. The concept of framing is also used to help make sense of the way in which commensuration processes *in themselves* seem to give rise to their opposite – differentiation – due to the unpredictable interactions between institutionalised commensuration processes and the social or political exigencies that drive alternative framings and commensuration processes. Differences are created not only between what is 'inside' and 'outside' the frame (i.e. between what is 'made the same' and everything else) but also by conflicts *between* frames of commensuration. This is a point with wider applicability beyond the specific case study, in a time when carbon markets globally appear to be undergoing fragmentation rather than convergence on the original idea that "a tonne is a tonne is a tonne" (Brohé et al. 2009, p.xxv).

The final chapter of this thesis summarises the principal arguments and contributions to knowledge, in answer to both the theoretical and empirical research questions. It reflects on the research process and the limitations imposed by the research methods, and considers a number of avenues for further research.

2. Methodology

2.1. Philosophical outlook and general approach

Before I move on to discuss the specific research methods employed in this thesis, I will briefly outline my position on fundamental questions of ontology (theory of the nature of existence or reality), ethics and epistemology (theory of knowledge), as this position influences what I have chosen to research, how I have conceptualised it (chapter 3, on theoretical frameworks) and how I have gone about it (as explained in the rest of this chapter).

I hope it is clear from my introductory chapter that I assume the existence of a mind-independent reality, in terms of the physical or natural world. This would brand me ontologically as a realist (as opposed to the idealist position that there is no mind-independent reality). For me, this ontological position is linked to an ethical position: I assume that there is a real world out there, and I care about what we are doing to it. For example, I care about the impact we are having on our planetary environment, both for its own sake (i.e. not for any instrumental benefit to myself or others) and on behalf of other organisms (including but not limited to people, both present and future), which I assume also to have independent existence. Thus I think that researching carbon accounting is important, not just because it can add to our knowledge of the world, but because I hope that this improved knowledge could lead to action which would help us to have a less damaging impact on species, ecosystems, landscapes and both present and future generations of human beings.

In terms of how we come to know what is going on in the (assumed) objectively real (natural) world, I lean towards empiricism, or "the idea that true knowledge [can] only be acquired through observation and that the only route to certain knowledge [is] through experience via perception" (Ryan et al. 1992, p.5) – although I would regard all knowledge as provisional rather than "true" or "certain" as used in this quotation. Therefore I rely – provisionally, until either falsified or a better alternative explanation is given – on the empirical observations made by atmospheric physicists, paleogeologists, oceanographers and other natural scientists, and – again provisionally – on the models they construct, based on these empirical observations, to represent our best current understanding of the reality of a complex phenomenon such as climate change.

Empiricism is traditionally contrasted with rationalism, or the view that 'true' knowledge can only be obtained through the use of reason, without the necessity for observation. Personally, I see these as complementary rather than mutually exclusive approaches to making sense of the world. Rationalism seems to me appropriate for the development of theories, using logic and/or mathematics to build more complex and predictive models from simpler principles. But in my view these theories then require empirical testing against observations to generate what I would regard as useful knowledge. Both approaches share a presumption against allowing personal beliefs, ideology or other psychological or cultural factors to influence the researcher's understanding of the world – in the case of rationalism, by relying on the use of reason alone (usually ignoring the possibility this itself could be culturally determined) and in the case of empiricism by attempting to remove the subjectivity of the researcher from the research process, for example through application of the 'scientific method' of systematic, repeated measurement and experiment.

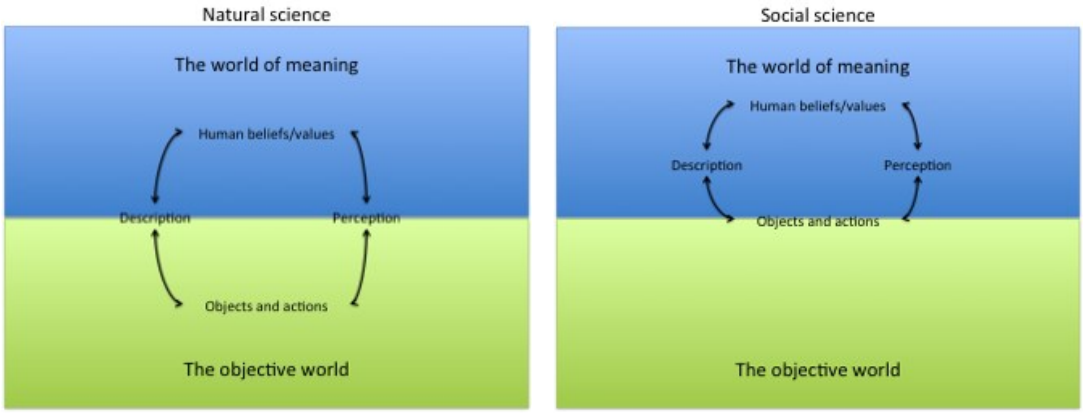
This presumption can be contrasted with the relativism of thinkers such as Kuhn (1962), who argue that observation in the natural sciences is so laden with the observer's beliefs, language and other subjective constructs (collectively the researcher's 'theory' or 'paradigm') that observations cannot be used to discriminate between one theory and another – at best both the observations and theory tell us something interesting about the historical context in which the observations and theorising were conducted. I agree that our knowledge of reality is always (necessarily) mediated by perception, but I don't subscribe to an extreme relativist view, at least in relation to understanding the natural world (the social world is another matter). The collective, repetitive and cross-cultural nature of most natural science observation may not ever eliminate, but surely helps to reduce, the influence of both individual perception and broader cultural filters.

The preceding discussion summarises my stance in relation to the ontology and epistemology of the *natural* world: broadly realist and empiricist, with the subjectivity of the observer's perceptions and communication minimised by collective, repetitive and shared approaches. I have outlined my position on this at some length because the validity, relevance and moral imperative of my research relies fundamentally on these assumptions about the validity of current scientific understanding of the effects of greenhouse gas emissions on the global climate. However, I am interested in questions to do with the meanings attached to carbon accounting and how it is practised by different actors. In other

words, the objects of my interest are not features or properties of the natural world, but rather of the *social* world. They range from internal concepts or abstractions (e.g. what carbon accounting means to certain individuals or groups) to externally observable artefacts and actions (e.g. codified carbon accounting standards, witnessed behaviour). The former are clearly not part of the directly observable natural world, and even the latter, whilst observable, have little or no meaning if divorced from their social context. Yet I am also part of that social context. Therefore while I think it is reasonable to think of a natural scientist (or rather a depersonalised collective of natural scientists) standing somewhat apart from, observing and describing an objectively real world, when it comes to questions of meaning and interpretation in the social sciences, both the subject and the object of research are essentially subjective. My research on carbon accounting involves at least two levels of subjectivity: my own, and that of the observed world. My subjectivity as observer is therefore inextricably involved in any attempt to make sense of these objects of inquiry.

I find the following diagram, which I have adapted from Ryan et al. (1992, p.20), helpful in illustrating this point: whereas natural scientists sit in the subjective world of meaning looking out on the objective world, with linguistic description and perception straddling the divide, a social scientist sits in the world of meaning looking inwards at objects and actions that typically have both objective and subjective dimensions.

Figure 4: The world views of the natural scientist and social scientist



Source: adapted from Ryan et al. (1992, p.20).

To the extent that some social scientists study more objective social phenomena (e.g. movements in published share prices of listed companies), I am ready to accept that a researcher's primary observations may be relatively value neutral and objective. However, when it comes to interpreting the meaning or significance of those observations, given that

human agency is always implicated somewhere in any social phenomenon, I think the influence of human beliefs and values is inescapable. In other words, the development of social science theory is always subjective and itself theory-dependent. While this might seem to lead to irreducible relativism or the lack of any 'truth' in social science, I think that following an iterative process of observation, theory generation, further observation and theory refinement, combined with constant questioning of the social determinants of perception and linguistic description, can lead to knowledge that, if not necessarily 'true' in a realist sense, can at least be useful in making sense of the social world.

My overall approach to research is loosely based on grounded theory (Glaser & Strauss 1967; Strauss & Corbin 1998), described as being "most suited to efforts to understand the process by which actors construct meaning out of intersubjective experience" (Suddaby 2006, p.634). Questions such as what carbon accounting is and how different actors define and lay claim to competence in this field are clearly to do with the construction of meaning, as it arises from the interactions between different subjects. Grounded theory offers "a compromise between extreme empiricism and complete relativism by articulating a middle ground in which systematic data collection [can] be used to develop theories that address the interpretive realities of actors in social settings" (Suddaby 2006, p.634). The method is based on two main principles: "constant comparison", meaning that data collection and analysis occur in parallel, and "theoretical sampling", under which further data collection is informed by the researcher's own subjective development of 'theory', based on the interpretation and categorisation of earlier data (as opposed to first generating hypotheses and then seeking data to test the hypotheses).

I am conscious of the fact that grounded theory is often misused, in various ways (Suddaby 2006). I am also aware that it can be considered both as a more general approach and a much more specific method, as originally outlined by Glaser & Strauss (1967), involving exhaustive 'coding' of empirical data (coding used here in several specific senses, including "the process of breaking down, examining, comparing, conceptualizing, and categorizing data" and subsequent "procedures whereby data are put back together in new ways… by making connections between categories" [Strauss & Corbin 1998, pp.61, 96]), 'memoing' or writing down emergent concepts and relationships between categories, and re-arranging or sorting the memos in order to build up a theory. I do not claim to have followed this specific method, but I do subscribe to the general approach of "constant comparison" and "theoretical sampling". My understanding of carbon accounting has emerged and developed in the course

of my research, through a process of generating categories and concepts from empirical data, then going back to further data which either confirmed or modified those categories and concepts. Ultimately, however, the validity of my conclusions is based mainly on the depth and breadth of my engagement with the subject – essentially fifteen years of participant observation, as outlined in the next section – rather than on the systematic application of a particular research method to a set of data.

One of the challenges with grounded theory is knowing when to stop: "Unlike more traditional, positivist research, grounded theory offers no clean break between collecting and analyzing data. Rather, a researcher must continue to collect data until no new evidence appears" (Suddaby 2006, p.636). A point of "category saturation" (Strauss & Corbin 1998) should be reached, when the data fit the generated categories in a way that is meaningful and important, and further sampling fails to generate new categories. Given the slipperiness of language and categorisation in general, I am doubtful of the implied objectivity of such a point of category saturation. Nevertheless, the reader needs to be assured that the researcher has not reached their conclusions based on incomplete or merely superficial observations. I think this is where any conclusions arising from grounded theory have to be put in the context of extant research, and ultimately judged by the reader's knowledge, and values, that condition their understanding of what is meaningful and important (which may not be the same as the researcher's understanding). I have therefore made every effort to place my research within the context of existing research, and where my work has already been published, I have included some commentary on how it has been received by other readers.

2.2. Research methods

I have used a number of different methods in my research, including analysis of many different types of documents and texts, participant observation, discussions with key informants and case studies. I describe each of these in subsequent sections. However, first I provide a reflection on the personal experience of carbon accounting that I brought to my research, before starting this PhD.

2.2.1. Personal experience

It is important to acknowledge that I did not start this research as a 'blank slate'; rather, it forms a continuation of around ten years of practitioner involvement in carbon accounting, prior to starting my PhD research in 2008. This experience has informed my research in various ways: it provided me with both depth and breadth of knowledge in the topic of my

research, before even starting on a formal literature review or further fieldwork; it has furnished me with an extensive network of informed experts (former colleagues, peers and business contacts) to whom I have a degree of privileged access; and it has provided me with a considerable amount of unique empirical material, in the form of copies of internal or ephemeral 'grey' literature, personal notes from projects, meetings and interviews, and an extensive electronic library of relevant documents. Some of this is subject to confidentiality restrictions as it was obtained in the course of employment, consultancy and the like, but this does not prevent it from having informed my understanding of the practice of carbon accounting and how it has evolved over time.

My background and transition from practitioner to academic in 2008 also reflects (coincidentally) a transition in the field of carbon accounting, where practice has run ahead of academic research until very recently (as I show in my review of the academic social and environmental accounting literature in chapter 4, compared with the longer history of practice in chapter 5). I think that this demonstrates a need for academic research to learn from practice, and vice versa, as opposed to the more traditional view where "Academics are seen as the developers of knowledge for others to consume, whereas practitioners apply the knowledge generated." (Burritt & Tingey-Holyoak 2012, p.41). This certainly doesn't fit my experience as a practitioner: rather, I can observe, from reviewing the academic literature and comparing it with my library of 'grey' literature, that over the period from around 1990 to 2007, the vast bulk of relevant 'knowledge' about carbon accounting – apart from pure 'physical' carbon accounting, dominated by academic natural scientists – was being produced by think-tanks, consultancies, non-governmental, governmental and intergovernmental organisations, professional bodies and commercial analysts, rather than academics. It is only since 2008 that academic social scientists have made a significant contribution.

Overall, I think that the academic-practitioner dichotomy can be an unhelpful one, as it doesn't reflect the reality, at least on the practitioner side, of a wide spectrum of different communities engaged in various combinations of generation of different kinds of knowledge and its implementation. It seems to function as a rhetorical device, by which academics privilege their access to knowledge, and unfortunately in the process also distance themselves from the world of 'practice'. I don't believe that I thought of myself as a 'practitioner' during that phase of my life, nor was I engaged only in 'implementation' of knowledge: many of my roles involved carrying out primary research, particularly when

working as a consultant. Sometimes that research was quantitative, involving modelling exercises, and at other times qualitative, for example involving analysis of interviews with key informants. In summary, as someone with a foot on both sides of the divide, I hope that my research can contribute to constructive learning between academics and practitioners.

My experience with carbon accounting started in 1999. My predecessor in the role of Senior Policy Officer, Sustainable Energy Policy at the Ministry of Energy and Utilities in New South Wales (NSW), Australia, bequeathed me a full set of Australian Greenhouse Office technical manuals on compiling a national greenhouse gas inventory. I found these fascinating, because they showed that behind the headline figures (Australia had just negotiated a target *increase* in emissions of 8% over 1990 levels in the Kyoto Protocol, in contrast to the overall *decrease* imposed on almost all other developed countries) lay a world of tremendous complexity and uncertainty, at the interface between scientific measurement and socio-economic decision-making. Despite this background of negotiation, complexity and uncertainty, the resulting numbers had unmistakable power: I remember colleagues at the time voicing concerns that the rate of land clearing in New South Wales and Queensland was accelerating in part due to fears that such activities would be constrained in future by Australia's Kyoto Protocol targets.

One of my first responsibilities was to manage the roll-out of the NSW Government Energy Management Policy, a new mandatory policy framework intended to help deliver the state government's target of a reduction in energy consumption of government buildings by 15% of the 1995 level by 2001, and 25% by 2005. Key components of the policy included establishing accountability (each agency to appoint a nominated energy manager, with ultimate responsibility assigned to the chief executive and included in their performance agreement), setting performance goals (quantitative targets and action-oriented goals), and monitoring, reporting and disclosing performance.

I therefore soon had to make use of the Australian Greenhouse Office manuals to help compile the first comprehensive energy and greenhouse gas inventory of NSW government operations (New South Wales Government 2000). This involved a massive data-gathering exercise, writing to the chief executives of 153 government agencies and state-owned enterprises, developing reporting guidelines, running capacity-building workshops, working with contractors to build a bespoke electronic reporting template and database, and working with individual agency energy managers to check and clean the reported data (the report

notes, "Anomalous data and possible errors were picked up in most reports, and on receipt of data summaries from the Ministry, agencies approved changes to data in approximately 47% of reports" [New South Wales Government 2000, p.15]). The final report contains detailed information on each agency's energy use, greenhouse gas emissions and energy expenditure, as well as normalisation factors to generate key performance indicators, which varied according to different types of operations (e.g. energy use per full-time employee and per square metre floor space for office buildings, per student for educational facilities or per occupied bed day for hospitals).

Like so many government initiatives, the NSW Government Energy Management Policy had a relatively short life. I left the Ministry in 2001 and I understand that one or two further annual reports were produced, before the process was abandoned – apparently because the targets were not going to be met.[6] A successor policy, the NSW Government Sustainability Policy, now has a target to reduce greenhouse gas emissions from energy use in government buildings to 2000 levels (1.5 million tonnes of carbon dioxide equivalent or $MtCO_2e$) by 2019/20.[7] This differs from the original targets (which were for energy consumption rather than greenhouse gas emissions from energy consumption), but nevertheless, for comparison, 1995 emissions from government buildings were 1.6 $MtCO_2e$, so the original targets should have corresponded to reducing this to 1.37 $MtCO_2e$ by 2001 and 1.21 $MtCO_2e$ by 2005, even if we conservatively disregard any benefit from reductions in the carbon intensity of the electricity grid over that period. In other words, the present target is less ambitious in absolute terms, and has also been delayed by nearly twenty years. This trajectory of initial enthusiasm for monitoring and disclosure, waning support as the difficulty of achieving lasting performance improvements sets in, leading to non-transparent re-statement of less ambitious targets, is a familiar one. In chapter 8 I describe the astonishing complexity of the UK's national carbon accounting; whilst the associated accountability frameworks are far more robust than they were in NSW in the early 2000s, this complexity could enhance the risk of similar policy failure in the UK in future.

However, I can also tell a contrasting story from the same period. My immediate colleagues in the Ministry's sustainable energy policy team were involved in monitoring the performance (in terms of greenhouse gas emissions per capita) of electricity retailers, as NSW was the first jurisdiction in Australia to impose greenhouse gas emissions-related

[6] Personal communication from a former Ministry employee.
[7] http://www.environment.nsw.gov.au/government/energy.htm (accessed 10 September 2013).

conditions on electricity licenses. At the time, a non-binding guideline stated that electricity retailers should reduce emissions per capita by 5% below the 1989-90 level by 2000/01. Public pressure arising from the disclosure that these targets were not being met resulted in the NSW Premier announcing a consultation on compulsory targets for the electricity sector in June 2001, which led to the establishment in January 2003 of the NSW Greenhouse Gas Abatement Scheme (NGAS), the first mandatory carbon market mechanism (for the electricity sector) in the world (IPART 2013).

Nevertheless, this policy 'success' (loosely considered, in the sense of moving from a demonstrably ineffective voluntary mechanism, to a mandatory regulation, leaving aside the question of how effective the latter may have been) has to be set in the context of a larger policy 'failure'. During this period (1999-2001) I was also involved in the development of policy proposals for a carbon market in Australia, representing the Ministry on an interdepartmental working group of civil servants, the NSW Emissions Trading Officers' Group. This group developed the first detailed proposal for a national emissions trading scheme (ETS) in Australia, submitted to the Federal (national) Government in 1999, making it one of the first serious, government-backed proposals for a national ETS in the world – the UK Government followed with its first consultation paper on a national ETS in November 2000, in the same year as the European Commission published its Green Paper on GHG Emissions Trading (Nye & Owens 2008; Ellerman & Buchner 2007; Convery & Redmond 2007; Convery 2009; European Commission 2000). However, the Federal Government at the time, under former Prime Minister John Howard, rejected the proposal, as part of a broader stance against climate change regulation, which included refusing to ratify the Kyoto Protocol. This contributed to a flowering of state-level initiatives, such as NGAS, as the oppositional politics between largely left of centre state governments and the conservative federal government became entrenched; but these initiatives, however pioneering, have to be set in the context of the larger climate change policy vacuum in Australia at the time.[8]

The late 1990s/early 2000s was a period of great enthusiasm for market mechanisms as an alternative to more traditional command-and-control regulation, and between 1999 and 2001 I also participated in similar working groups developing market mechanisms for achieving

[8] This period lasted until June 2007, when the Howard government announced a change of heart, promising the introduction of a national emissions trading scheme by 2012 at the latest, but then lost the general election to the Australian Labour Party, which immediately ratified the Kyoto Protocol and later brought in a national carbon pricing mechanism, effective from July 2012. After little more than a year of operation, the carbon pricing mechanism is under threat, as the new conservative Prime Minister Tony Abbott, elected in September 2013, made revoking the tax an election pledge.

national renewable energy targets, and for control of NOx emissions (one of the principal contributors to urban smog) in the Sydney region. Thus, in my experience, the measurement and reporting of greenhouse gas emissions for the purposes of voluntary disclosure and performance measurement was closely related to similar activities required for the effective operation of emerging market mechanisms as an alternative to more direct government regulation.

From 2002 I worked in the UK as a consultant, specialising in energy and emissions trading. I was closely involved in the development of the EU Emissions Trading Scheme (EU ETS), advising clients on the likely impact of the new EU legislation from early 2003 onwards. At this time I was a member of the 'initial allocation and ongoing allocation' sub-group of an industry body, the Emissions Trading Group (ETG)[9], which played a key role in lobbying the UK Government during a critical 'policy window' (Kingdon 1995) in which the detailed rules for national implementation of the EU ETS were determined (2003-2004). The ETG was originally set up in July 1999 to represent business interests in the design of the earlier UK Emissions Trading Scheme (UK ETS), which commenced in 2001. "In its official capacity, the UK ETG was a joint effort of the Confederation of British Industry and ACBE [Advisory Committee on Business and the Environment] to represent the case for emission trading in the UK… Unofficially, it was a politically well heeled advocacy coalition (see Sabatier 1988)…" (Nye & Owens 2008, p.5). This description from its earlier period also seems to aptly describe its role during the period of my involvement.

Between September 2003 and August 2004 I managed three separate consultancy projects assisting the UK Department for Environment, Food and Rural Affairs (Defra) with the analysis of around 550 responses to consultations on the design of the initial UK National Allocation Plan (NAP) under the EU ETS. This gave me a broad insight into the motivations and concerns of different stakeholders. No sooner had the NAPs for Phase I of the EU ETS (2005-2007) been finalised than the same issues had to be re-examined in order to prepare the NAPs for Phase II (2008-2012). In 2005 I managed two studies for the (then) UK Department of Trade and Industry (DTI) looking at the impact of different allocation options on the UK electricity sector.

From 2005 I started to become involved in the emerging Kyoto Protocol Clean Development Mechanism (CDM) and Joint Implementation (JI) carbon markets, becoming a registered

[9] See http://www.etg.uk.com (accessed 18 November 2013).

'CDM methodologies expert' with the UNFCCC in 2005, and a member of the JI Supervisory Committee roster of experts in 2006. As a CDM methodologies expert, I provided independent reviews of proposed new carbon accounting methodologies. CDM methodologies were developed in a bottom-up manner, based on proposals put forward by developers of emission reduction projects that hoped to use the proposed methodologies. The first proposals were put forward in September 2003, and my first review was conducted in mid-2006 on the 152nd proposed new methodology, which was initially rejected, but then approved after revisions. Over the next six years I reviewed another ten proposed new methodologies (out of the total of 365, as of November 2013), for projects ranging from energy efficiency to abatement of fluorinated compounds from semiconductor manufacturing. I also became involved in the accreditation audit of approved CDM auditors. This involved being part of a team (one CDM methodologies expert and one generic auditing expert) conducting desk reviews of documentary evidence, 'witnessing' on-site audits while they were taking place, and visiting head offices as part of 'performance assessments' to assess whether a given entity met the criteria for accreditation or re-accreditation. This experience was particularly illuminating, as it gave me an insight into the extremely rapid evolution of standards for CDM auditor accreditation and performance, the struggle of auditors to comply, and the pressures this imposed in turn on the developers of emission reduction projects (which required the auditors' approval).

At the same time, I started working as a consultant advisor with EcoSecurities, a pioneer in the development of carbon offsets from CDM projects in developing countries. I witnessed the company's trajectory from small start-up, through its initial public offering on London's Alternative Investment Market, followed by rapid growth to a peak of around 300 employees, acquisition by JP Morgan in 2009, after which it gradually contracted in scope to a mere handful of employees, with the remains of the business sold to Swiss trading house Mercuria in June 2013.[10] EcoSecurities developed the first project to be successfully registered under the CDM, structured some of the first transactions of carbon credits, developed 12 of the CDM's approved carbon accounting methodologies, and contributed to the development of the WRI/WBCSD GHG Protocol (WBCSD & WRI 2001; WBCSD & WRI 2004) corporate accounting and reporting standard, and the dominant standard for voluntary carbon offsets, the Verified Carbon Standard (originally the Voluntary Carbon Standard, VCS). With EcoSecurities, I worked extensively on various aspects of the development of tradable carbon offsets from emission reduction projects, under the CDM

[10] Source: Reuters Point Carbon, 4 June 2013: http://www.pointcarbon.com/news/1.2401344

and voluntary carbon markets. For example, in 2006 and 2007 I helped to shape a voluntary market strategy for EcoSecurities, which included drafting an internal voluntary carbon offset standard and providing inputs to the development of the VCS via Marc Stuart, a Director of EcoSecurities who was on the original VCS Steering Committee. I also worked with corporate clients on the preparation of greenhouse gas inventories and some early product carbon footprints, for example of pineapples and other fresh fruit exported from Africa to Europe, or cod fished in the North Sea and processed in China for European consumption, compared with air-freighted tuna or lobster. This was well before the release of the first standard specifically for product carbon footprinting, PAS 2050 (BSI 2008). Similarly, in early 2007 I presented a framework for footprinting complex supply chains at an industry conference; later that year Wal-Mart in partnership with CDP piloted an initiative with its suppliers which in turn led to the development of the CDP supply chain program from 2008 onwards (CDP 2008). A common theme across all of these activities is that this was a period in which standards and procedures were being created for the first time. If a standard didn't exist, as practitioners we either developed our own, and/or contributed to collaborative efforts (nearly always industry- rather than government-led) to develop a standard.

I turn now to discuss the research methods employed during the course of my PhD research, including analysis of documentary sources, participant observation and case studies.

2.2.2. Documentary sources

A practice such as carbon accounting typically leaves traces in the form of documentation: reports, agendas and minutes from meetings, presentations, conference papers, correspondence, standards, consultation documents and responses, working papers, briefing papers, guidelines, manuals and press releases. I started my research by reviewing the extensive archive of both electronic and print material on carbon accounting from my previous work experience. I have continued to add to, and iteratively reviewed, this archive of 'grey' literature during the course of my PhD research. I keep track of around 600 such documents in my reference management database, but this represents only a fraction of the larger set of documents I am familiar with and know how to find, such as CDM methodologies and voluntary carbon offsetting standards.

I have used this documentation in three principal ways. In the first place it provides the overall context for my research: "background information as well as historical insight"

(Bowen 2009, p.29) as well as a way of formalising and structuring the "preunderstanding" (Gummesson 1991) obtained through my previous experience. Second, I have treated this corpus of 'grey' literature as part of my primary empirical material, that I have sought to interpret alongside further data drawn from participant observation and case studies. This combination of sources allows for 'triangulation' or "the combination of methodologies in the study of the same phenomenon" (Denzin 1970, p.291) in order to "seek convergence and corroboration through the use of different data sources and methods" (Bowen 2009, p.28). Third, I have used documents as citeable evidence for observations or interpretations which may have been drawn originally from confidential discussions with key informants or other non-citeable sources. To some extent, this counters the general disadvantage of relying on non-retrievable data (e.g. confidential or ephemeral documents, or unrecorded key informant responses).

A different kind of document analysis is used in chapter 4, which reviews the academic social and environmental accounting literature on carbon accounting. The specific method used there is explained further in that chapter. In chapter 8 I also use the electronic news archive LexisLibrary to review the news coverage of carbon offsetting over a certain period. Both of these involved the use of electronic keyword searches to identify potentially relevant documents which were then read and analysed in detail.

Where I have used documents as primary empirical material, I have imported the relevant documents (where possible) into the reference management software Mendeley, which allows many different forms of text (papers, reports, transcribed interviews, web pages) to be brought together in a single package, where each source's bibliographic information can be assigned. I have used several functions within the software to support my interpretation of these texts: 'tags' which can assign texts to different categories, highlighting and 'notes' which can help to reduce a longer text to key points of interest and to record one's thoughts about emergent concepts and connections. I have also made use of the software's ability to filter all documents (by tags, authors, publications or authors' keywords) and the ability to search for key terms both across and within texts. The tags, highlighting and notes functions are roughly analogous to coding and memoing as originally expounded by Glaser & Strauss (1967) as methods of developing grounded theory. However, my use of coding has been relatively 'holistic', moving rapidly from high-level codes to identification of emergent themes and categories. As Saldana (2009, p.119) observes, "Holistic coding is applicable when the researcher already has a general idea of what to investigate in the data...". Without

my pre-existing experience of carbon accounting, I would have needed to conduct more detailed coding and iterative analysis of documents in order to arrive at similar conclusions.

2.2.3. Participant observation

Studying the practices of carbon accounting could be considered as a form of social anthropology. Whilst undoubtedly less exotic than the customs of Trobriand Islanders might have been to a European in the early twentieth century (Malinowski 1922), the practices of carbon accounting are nevertheless also relatively 'new' and unfamiliar in today's social context. Thus the study of these practices is amenable to an anthropological approach which involves both immersion in the context, culture or community of interest, and standing back to analyse it: in other words, participant observation.

Carbon accounting shares with other environmental issues the characteristic of involving "large numbers of actors whose behavior bears on [the] outcome. Often, these actors are heterogeneous, geographically dispersed, and engaged in behavior that is difficult to observe and measure" (Hoffman & Ventresca 1999, p.1369). This poses a challenge for participant observation, or indeed any other research method that aims to understand such practices at a higher level of generality than individual cases. Nevertheless, whilst practitioners of carbon accounting are globally dispersed and hence cannot be comprehensively studied 'in the field' at a single geographical location, they do tend to inhabit certain cultural spaces, such as particular government departments or agencies (e.g. those with responsibility for energy, climate change or environmental protection), intergovernmental bodies (e.g. the UNFCCC or IPCC), specialist consultancies or divisions within larger consultancies (e.g. PwC's sustainability and climate change team). Certain key policy-forming events such as the annual UNFCCC Conference of Parties (COP) also serve to bring together many of the dispersed individuals involved in carbon accounting. Therefore it is technically feasible to conduct 'fieldwork' through attending such events and/or direct researcher participation in the relevant cultural spaces. This internal perspective complements external observation of evidence, such as the grey literature discussed in the previous section, that documents different carbon accounting practices.

In the following tables I have classified my participant observation experiences into three different categories: individual practitioner roles, workshops and events, and discussions with key informants. The first category comprises roles as practitioner or expert on an individual basis with respect to specific organisations relevant to carbon accounting (Table

1). While in each case the relevant organisations would have been aware of my simultaneous status as a researcher/academic, they would not expect me to report explicitly on their activities. A different kind of participant observation opportunity has been through attending workshops or events with significant numbers of carbon accounting practitioners. A selection of the largest and most significant of these events is shown in Table 2. At some of these events my role has been relatively passive (as an attendee) and in others more active (as a presenter or co-organiser). In all cases these events have provided many different kinds of data, including notes from, recordings or electronic copies of formal presentations by other practitioners and experts, handouts, briefing or background papers, reports, and notes from discussions with key informants (sometimes in a formal setting, but more often informally). A third kind of participant observation has been one-to-one or small group discussions with key informants, a small selection of which are indicated in Table 3. Names, titles and other details which would permit identification of the individuals (including dates) have been omitted. I do not call these discussions 'interviews' because of the impression this gives of "a formal structured interrogation which is controlled by the researcher" (Easterby-Smith et al. 1991, p.78). Rather, these were usually unstructured conversations, typically conducted away from the informant's day-to-day environment (for example at the workshops or events in Table 2, in public spaces such as cafés, or on the university campus as a relatively neutral territory). As my interest has been in understanding and making sense of the practices of carbon accounting at a generic level (e.g. the frames and communities of chapters 6 and 7), as opposed to individual understandings, I have not approached discussions as the source of transcribed texts to be analysed. Even though some discussions were recorded, in general I have relied mainly on notes written both during and immediately after each discussion.

Table 1: Participant observation – individual practitioner roles

Participant observation experience	Period	Description
Member of CDM Accreditation Assessment teams, various locations, Brazil, Ecuador, Germany	Oct 2008 to Jun 2010	Details and documents are confidential, but my notes provide a useful insight into the development of standards and the practice of a particular form of carbon audit.
Meetings with UNFCCC Secretariat, Bonn, Germany	26-27 Mar 2012	Facilitated a two-day workshop on carbon markets for members of the UNFCCC Secretariat Strategic Policy and Marketing teams. Information from informal discussions.
Member of Forestry Commission Carbon Advisory Group, Edinburgh, UK	From Aug 2013	Invited to join this group of experts advising the Forestry Commission on the development of its Woodland Carbon Code (a carbon accounting standard). Access to documentation and information from informal discussions.

Table 2: Participant observation – workshops and events

Participant observation experience	Period	Description
COP-14, Poznan, Poland	3-10 Dec 2008	Annual international climate change summit – Conference of Parties to the UNFCCC. Attended open meetings of the negotiations and numerous side events. Access to documentation and information from informal discussions.
CDM Joint Coordination Workshop, Bonn, Germany	27-28 Apr 2009	Invitation-only event for personnel with official roles in the CDM (invited as CDM methodologies expert). Access to electronic copies of presentations and information from informal discussions.
COP-15, Copenhagen, Denmark	11-17 Dec 2009	As per COP-14 above.
First Sustainable Development Mechanisms (SDM) Joint Coordination	24-25 Mar 2012	As per CDM Joint Coordination Workshop above.

Workshop, Bonn, Germany		
Carbon Financial Accounting Workshop, Edinburgh, UK	14-15 Jan 2013	Invitation-only, joint academic-practitioner event which I co-organised and at which I gave a presentation, 'Beyond EU ETS allowances: Other schemes, offsets and stocks'. Supported by the Climate Disclosure Standards Board (CDSB) and International Emissions Trading Association (IETA). Non-academic attendees included representatives from the supporting organisations, plus the Institute of Chartered Accountants of Scotland (ICAS), the European Commission and the International Accounting Standards Board (IASB). Notes from presentations and discussion with key informants.
Opportunities in Woodland Carbon, Edinburgh, UK	27 Jun 2013	Invitation-only stakeholder event at which I gave a presentation, 'Introduction to Forest Carbon Markets'. Organised by the Edinburgh Centre for Carbon Innovation, with a focus on the Woodland Carbon Code, a UK forest carbon accounting standard. Notes from presentations and discussion with key informants.
Climate Justice in Practice – Experiences of the Plan Vivo Standard, Edinburgh, UK	7-8 Oct 2013	Invitation-only stakeholder event at which I gave a presentation, 'Carbon markets – current status and future outlook'. Organised by the Plan Vivo Foundation, a forest carbon accounting standards body. Notes from presentations and discussion with key informants.

Table 3: Participant observation – discussions with key informants (representative sample only)

Role	Description
CDM Methodologies Panel Member	Independent expert appointed to UNFCCC body responsible for producing recommendations on carbon accounting methodologies to the peak decision-making body, the CDM Executive Board.
Former Member of the CDM Executive Board	Independent expert with a long history of involvement in a variety of UNFCCC and carbon market roles
Senior European Commission official	Senior official in DG-Environment with a long history of involvement in the development of the EU ETS
Senior UK Government officials	Two senior officials in the UK Department of Energy and Climate Change
Carbon broker	Managing Director of a European carbon brokerage business
Forest carbon accounting expert	Independent expert with around ten years' experience of carbon accounting in forestry and agriculture
Carbon market information services provider	Senior manager in a specialist carbon market information services provider company
Carbon market industry body	Head of an industry body representing firms with an interest in carbon markets
Carbon footprint certification assessor	Qualified assessor of carbon footprints for a certification body
Carbon auditors	Qualified assessors of emission reduction projects under the CDM, JI and voluntary carbon markets, working for several different accredited carbon auditing companies
Carbon accounting standards bodies	Individuals working for the following standards bodies: Plan Vivo, Woodland Carbon Code, Gold Standard, Verified Carbon Standard, Carbon Disclosure Project, Climate Disclosure Standards Board

It will be clear that my three categories are not mutually exclusive. For example, discussions with key informants have taken place during or around workshops and events, as well as on separate occasions, and I have been invited to specialist workshops and events via individual practitioner roles. Furthermore, my practitioner and researcher roles have overlapped throughout and are difficult to separate out from one another. Hence I find I cannot easily

classify my participant observation into the continuum of four categories proposed by Junkers (cited in Easterby-Smith et al. 1991, p.96) of complete participant, participant as observer, observer as participant and complete observer. Junkers' classification is based on the idea of researching a close-knit, well defined group, and depends on the extent of group membership and disclosure of the researcher's role, both of which are assumed to be clearly identifiable (the researcher is a member of the group under the first two categories, but only the middle two categories involve disclosure). In the case of my research, the 'group' of 'practitioners of carbon accounting' is qualitatively quite different: first of all, it depends on one's definition and understanding of carbon accounting, which is something that the research provides an emergent answer to, rather than being an a priori given (see chapters 5 and 6); it involves multiple communities rather than a single group (see chapters 5, 6 and 7); and the individuals concerned are widely dispersed. Thus group membership is less easily defined, although due to having worked for a long period of time across multiple areas of carbon accounting, I can claim membership in many (but not all) relevant communities, which would place my research in the first two of Junkers' categories. However, some occasions, such as attending UNFCCC events, provided opportunities for observation where I was effectively 'hidden in plain sight' as a member of the audience. In such cases, disclosure of my role as researcher would be impracticable, thus it approximates 'total observation' – yet at the same time, access to the meeting itself may have depended on my status as a practitioner. The alternative categories put forward by Easterby-Smith et al. (1991) of researcher as employee, research as explicit role, interrupted involvement and observation alone are also unsatisfactory, largely because they likewise assume clearly identifiable and defined roles and boundaries (researcher, employee, organisation) which are not necessarily applicable in my research.

In addition, as noted in section 2.2.1, I have drawn on my previous experience as a practitioner of carbon accounting, despite the fact that I did not start out (in 1999) with the intention of carrying out research through participant observation. However, I was able to revisit and to be informed by these earlier experiences through reviewing notes and documentation that I had kept from this period. These materials may not be as extensive on a day-to-day basis as a typical field-work diary, but they are extensive in time (spanning ten years), space (having worked in Australia, the UK and on consultancy projects in over 20 other countries) and subject matter (covering many different types of carbon accounting). In addition, they are significant as they cover a particularly formative early period in the development of carbon accounting, carbon management and carbon markets.

My previous (and on-going) status as a practitioner of carbon accounting was vital to enabling these participant observation opportunities. The explicit roles in Table 3 would not have been available without this, access to most of the events in Table 2 would have been either impossible or at least very difficult to arrange, and likewise access to most of the high-level key informants in Table 3 would have been extremely challenging to achieve, and time-consuming to identify the individuals, make contact, establish trust and arrange meetings. This freed me from several of the common difficulties with participant observation as a method, such as initial exclusion from the community of interest and having to build trust, needing to 'learn the language', and so forth (Easterby-Smith et al. 1991). Some (but not all) of the key informants were known to me already, and a number of discussions were pursued opportunistically or fortuitously at the meetings described in Table 2. Sometimes, random encounters within the right setting, for example at the lunch table at an international gathering of experts, provide the most illuminating insights.

However, there were also inherent disadvantages associated with my practitioner status and this kind of participant observation. Presenting myself as 'a PhD student' would undoubtedly have elicited different kinds of responses, and have made it easier to carry out more formal and structured interrogations, as well as to record responses and thus to analyse them in different ways (e.g. close discourse analysis of spoken 'texts'). Some of my discussions with key informants were recorded (those feeding into chapter 8 in particular), but most were not, as this would have formalised and constrained conversations which were often particularly informative due to their informal nature. Above all, perhaps my pre-existing and on-going practitioner status leaves me open to the charge of having 'gone native' and therefore being unable to observe or communicate my observations with any degree of objectivity.

With respect to the objection that I might be unable to *observe* with any degree of objectivity, I would point out that my previous roles within the carbon accounting communities I observed – as independent consultant or independent expert – were all characterised by a strong element of publicly recognised independence. One's reputation depends on maintaining overall impartiality and integrity despite working across multiple projects with multiple clients, some of whom might be in direct competition with one another. Therefore to the extent that I continued to participate in the communities in these roles (either explicitly, for example in the case of attending workshops restricted to people involved in some recognised capacity in the UNFCCC, or implicitly in the case of meetings

with known individuals who may have treated me as continuing in my former roles, although aware that I was now also a researcher), I would argue that my stance has always been one of independence and objectivity.

I acknowledge some constraints on my ability to *communicate* my observations. For example, in the case of my membership of CDM Accreditation Teams, I am unable to publish specific information that was disclosed or became known to me during the course of those activities, as my involvement was subject to strict confidentiality agreements. From a research perspective this is a pity, as otherwise I could tell an interesting story about how CDM accreditation proceeded, in one particular case, from observation of what seemed a fairly straightforward and well-conducted site visit, to deeper investigation of internal procedures for qualification of auditors, to the discovery of practices which led to an auditor's suspension, review and significant internal practice changes, ultimately resulting in re-instatement. Yet while I cannot provide such a case study, I am nevertheless able to communicate broader, non-case-specific observations informed by this participant experience. Also, this example is the exception, as most of the other participant observation opportunities involved observation of what were essentially public meetings, although access to these meetings was restricted (relatively loosely in the case of the COPs, which require one to be nominated by an approved UNFCCC observer organisation; more tightly in the case of the UNFCCC coordination workshops, which were invitation-only).

In summary, I have used a variety of different types of information from my long-term participation in carbon accounting practices, arising from individual interactions with key organisations, group interactions at workshops and events, and discussions with key informants. The data available to me include my own notes as well as a variety of documents. My notes reflect both salient points made by the informant and my initial interpretation at the time. These notes were then subject to further comparison and interpretation in keeping with the grounded research method. The existence of different data sources enabled triangulation between them, as well as between 'internal' data from participant observation and 'external' analysis of public documents, with interpretation consisting of continual movements back and forth between these primary sources.

2.2.4.Case studies

Case studies offer the opportunity of analysing and understanding the practice of carbon accounting in a specific example. Ryan et al. (1992, pp.114–115) discuss the differences

between descriptive, illustrative, experimental, exploratory and explanatory case studies. As carbon accounting is relatively new and under-researched, even purely descriptive case studies can be illuminating, and potentially valuable if what they describe can provide the basis for wider learning. Again, because virtually everything is relatively new and innovative, almost any case could be considered to be 'illustrative'. Chapter 6 contains what could be regarded as five very brief case studies, each describing or illustrating a 'frame' of carbon accounting. However, for the most part I have used case studies to explore and explain the reasons for observed carbon accounting practices. Ryan et al. note that "The distinctions between these different types of case studies are not necessarily clear-cut" (1992, p.115). I have used the theoretical frameworks discussed in chapter 3 to help understand and make sense of the observed practices. An example of this is the case study of the Climate Disclosure Standards Board (CSDB) in chapter 7, where the theoretical concepts of epistemic communities and boundary-work are combined to help explain the emergence of this new standard-setting body, and the 'work' that it does in mediating between the competing interests of different communities.

A more detailed case study in chapter 8 has been used to explore my research question to do with how an improved understanding of carbon accounting might help to resolve accounting-related problems in carbon management and markets. This case looks at a situation where carbon accounting-related problems are currently preventing investment in actions that would help to mitigate human-induced climate change (in this case by sequestering carbon in UK forests). The reasons for pursuing this 'negative' case study were twofold: first, it shows, perhaps more clearly than a 'representative' case, that carbon accounting has material consequences; and second, it provides an opportunity to explore whether and how an improved understanding of carbon accounting could help to solve these problems.

I hope it is clear from my discussion at the start of this chapter that as my research is not in the positivist tradition, I do not view case studies as 'small samples' which poorly represent possible generalities. Rather, I view case studies as "an opportunity to understand social practices in a specific set of circumstances" (Ryan et al. 1992, p.120) and as a place to develop and test theoretical generalisations. As carbon accounting is not a well established area of research with a well established theory or theories, my cases are not 'critical' cases which directly test a theory's limits or weaknesses, but rather 'exploratory' cases used for theory development. The sources of empirical evidence for my case studies are the same as described in the previous sections – document analysis and participant observation, with

theory developed using a grounded approach to analysis of the empirical material. The case in chapter 8 draws in part on a collaborative research report for the UK Forestry Commission (Ascui & Neeff 2013). That report drew on my prior research, and also provided an impetus for further research which informed the case study.

Finally, I would like to note that the process of fieldwork, reflection, analysis and writing up has not been linear by any means. In part this has been because I have written up parts of the research at different times in order to suit the publication windows offered by three special issues of academic journals on carbon accounting. But even in relation to any single paper or chapter, I would say that understanding has emerged non-linearly. "Interpretation moves from evidence to ideas and theory, then back again." (Okely 1994, p.32).

2.3. Summary

This chapter begins by setting out my overall approach to the fundamental questions of ontology, epistemology and ethics, explaining how this leads me toward an interpretive, social constructionist methodological approach to my present topic of research. I have discussed my use of grounded theory as a general approach, and explained that in keeping with the overall paradigm, my research design is based on a high degree of personal involvement (as opposed to idealised detachment), small samples of exploratory and explanatory case studies (as opposed to large samples to test hypotheses statistically), generating new conceptual understanding (as opposed to testing well established theories), on the basis of empirical data derived from fieldwork methods (as opposed to experimental methods). I have outlined my previous experience in carbon accounting at some length because this provides essential background or pre-understanding of the topic, is a source of empirical data in itself, and determines my subsequent status as participant observer. Finally, I discuss my research methods in more detail in relation to analysis of documents, participant observation and case studies.

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3. Theory

Parts of this chapter describe theoretical frameworks that have also been used in Ascui & Lovell (2011) and Ascui & Lovell (2012). Section 3.2 provides my own perspective on the concept of framing. It is different to the discussion of framing which appears in section 3 of Ascui & Lovell (2011), although it explores the same core concepts. I acknowledge my co-author's contribution to the first draft of the latter, and wish to acknowledge a more general debt to my co-author for pointing me towards the theoretical frameworks of sections 3.2 and 3.3 (framing and commensuration). Sections 3.4 and 3.5 (epistemic communities and boundary-work) have been published as sections 2.1 and 2.2 of Ascui & Lovell (2012). These sections were primarily drafted by myself and have been retained here, with minor variations and some further additions.

3.1. Introduction

In this chapter I discuss the theoretical constructs I have used to help make sense of the practice of carbon accounting as empirically observed through my research. As explained in chapter 1, I did not set out with a theoretical framework or testable hypothesis already in mind, which the empirical data would confirm or falsify. Rather, I started with a large body of empirical evidence from my prior experience, to which I then added further empirical material, whilst constantly moving back and forth between the data and interpretation, which included a process of investigating various theoretical frameworks as they were suggested by the literature, advisors or co-authors (as discussed in chapter 1). In the end, I have drawn on several theoretical frameworks from different disciplines to help make sense of the empirical material, whilst recognising that each of these provide only partial support and none can be considered a 'theory of carbon accounting'.

My approach to theory falls within the 'alternative' paradigm of accounting theory, which "emphasizes 'interpretation' rather than 'explanation' or 'prediction' when studying human behaviour" (Ryan et al. 1992, p.4), as opposed to the 'mainstream', positivist approach (Chua 1986). Chua (1986) divides the 'alternative' paradigm into the 'interpretive' and 'critical theory' schools of thought. The former is characterised by its attention to language and anthropological observation as a route to understanding the meanings, norms and other social constructs which together make up the individual's social world in its particular historical context. This interpretive understanding of the social world can be criticised for its tendency to "focus on micro-social interaction…[and thus] to neglect major conflicts of

interest between classes in society." (Chua 1986, p.619). In other words, while it allows for the possibility of social change through individual reflection on and awareness of the way in which social knowledge is constructed, it does not entail any particular political stance towards social change and cannot discriminate between alternative world-views. Critical theory, on the other hand, argues that "interpretation *per se* is insufficient. It cannot appreciate that the world is not only symbolically mediated, but is also shaped by material conditions of domination. Language itself may be a medium for repression and social power." (Chua 1986, p.621). Critical theorists thus believe that "through an examination of contemporary social and political issues they could contribute to a critique of ideology and to the development of a non-authoritarian and non-bureaucratic politics." (Held 1980, p.16).

I am reluctant to attach myself unequivocally to either the interpretive or critical theory schools of thought, or to a particular theorist. However, while I am interested in the way in which carbon accounting as a discursive act is performed and institutionalised, which is aligned with an interpretive approach, I think that it would be both naïve and theoretically incomplete to disregard the political implications of this social construction, given the physical implications of climate change and the all-pervasiveness of fossil carbon in the world economy and current socio-political systems. Likewise, while I start out with an essentially apolitical, interpretive research question (to do with what carbon accounting is and how it is understood in different contexts) I am ultimately interested in applying this understanding in order to make (or at least facilitate) positive changes in the real world (where climate change actually happens). Thus my other research questions are more 'political' in nature (how different communities interact, and how an improved understanding of carbon accounting can ultimately help to make carbon management and markets more effective). Therefore on balance I would characterise my approach as critical, but selective in its use of concepts from different theorists, rather than adopting a particular theory or theorist wholesale.

The key theoretical concepts I have drawn from include framing (from its use in the policy discourse literature and economic sociology), commensuration (from sociology and sociological studies of accounting), epistemic communities (from international relations) and boundary-work (from the sociology of science). These concepts range across interpretive, German and French critical theory backgrounds, although none are very closely associated with the original theorists in these fields (e.g. Berger, Luckmann, Habermas or Foucault). For example, my discussion of framing starts with an essentially interpretive view (originally

from the sociology of Erving Goffman) but then moves on to discuss its use by Callon, a thinker heavily influenced by French critical theory. Likewise, the main author I discuss under commensuration (Espeland) works mainly in the tradition of German critical theory, but the concept has been considered elsewhere from a Foucauldian perspective (D'Agostino 2003).

3.2. Framing

Framing is a very widely used concept in a variety of disciplines. Its sociological use is often attributed to the work of Erving Goffman, who defined frames as "schemata of interpretation" that allow individuals or groups to "locate, perceive, identify, and label" the world around them (Goffman 1974, p.21). Frames are constructed both at the individual conceptual level as a psychological response and at a collective level through discursive acts. I am primarily interested in this collective level. Carbon accounting (however interpreted – see chapter 5) is a discursive act – not something 'given', in the natural world, but something socially created through spoken or written language, symbols or numbers and communicated to others – like accounting in general (Arrington & Francis 1993). Furthermore, it is a discursive act with particularly resonant ethical and policy implications, due to its vital role in shaping and enabling the 'management' of climate change, and because the giving of an account implies some degree of acceptance or attribution of responsibility for the negative impacts of climate change (whether retrospective, prospective, or both). Thus the ethical burden of carbon accounting, which underpins its relevance to policy-making, comes about due to the two-way connection it makes between the subjective world(s) of discourse and the objective world of nature.[11] How we perform carbon accounting can materially impact the natural world, and it matters to us because of those impacts. This puts it in a particular class of discursive acts with strong ethical and policy implications.

This suggests that the literature on policy discourse analysis, and environmental politics in particular (Dryzek 1997), could provide useful conceptual frameworks for making sense of carbon accounting. Discourse is defined by Hajer & Versteeg (2005, p.175) as "an ensemble

[11] I am not arguing that this two-way connection between carbon accounting and the social and environmental impacts of climate change is structurally unique, as I would agree with Burchell et al. (1985, p.385) that a "dialectic of accounting… and its environment" is inherent in any form of accounting whatsoever, as any accounting will tend to be both reflective and constitutive of the reality in which it operates. However, this dialectic relationship is particularly ethically charged in the case of carbon accounting, due to the magnitude and scope of the impacts of climate change (affecting a large proportion of all life on the planet for centuries to come, as opposed to, say, a particular form of tax accounting which might have a short-term impact on a few hundred companies within a single country).

of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices." Another useful definition, from an explicitly Foucauldian perspective, is given by Litfin (1995, pp.252–3):

> "Discourses… are broader sets of linguistic practices embedded in networks of social relations and tied to narratives about the construction of the world. As determinants of what can and cannot be thought, discourses define the range of policy options and operate as resources which empower certain actors and exclude others. They also serve as sites of resistance, fomenting the emergence of counter-discourses."

According to Hajer & Versteeg, analysing discourse is important for three main reasons. The first two have to do with revealing and foregrounding the role of language in both politics and practice. "Language has the capacity to make politics, to create signs and symbols that shift power balances, to render events harmless or, on the contrary, to create political conflict" (Hajer & Versteeg 2005, p.179). At the level of practice, "actors exercise power through trying to impose a particular frame or discourse on a discussion" (Hajer & Versteeg 2005, p.177). Given the complexity and messiness (Sharp & Richardson 2001, p.194) of environmental problems such as climate change, discursive simplifications (such as shared storylines and metaphors) are inevitable, even if not consciously political in motivation; and given the multiplicity of communities involved in environmental issues (e.g. different disciplinary experts, stakeholders, publics) it is unsurprising that these discursive simplifications can conflict and lead to misunderstandings. The third reason for analysing discourse is "its capacity to answer 'how' questions. The analysis of discourses can help to illuminate why certain definitions do or do not catch on at a particular place and time and to explain the mechanisms by which a policy does or does not come about." (Hajer & Versteeg 2005, p.177). In short, within the social constructionist, interpretive paradigm of my research, analysing discourse has the potential to help answer my fundamental questions about what carbon accounting is, and how it is understood and socially constructed in different contexts. Therefore in chapter 5 I pay close attention to the terminology used by different actors to describe the practices of carbon accounting, and relate this to the broader politics in which these practices emerged. Chapter 6 explicitly uses the concept of framing to make sense of the many different views and practices of carbon accounting, while part of chapter 7 analyses the discursive efforts made by accountants to extend their claims of competence in carbon accounting.

In the policy discourse literature, frames are "…a way of selecting, organizing, interpreting, and making sense of a complex reality to provide guideposts for knowing, analyzing, 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 & Schön 1993, p.146). Policy discourse in this case means "the interactions of individuals, interest groups, social movements, and institutions through which problematic situations are converted to policy problems, agendas are set, decisions are made, and actions are taken." (Rein & Schön 1993, p.145). Climate change is undoubtedly one such "problematic situation". Rein & Schon appeal to the concept of framing in order to make sense of policy controversies – situations which "cannot be settled by recourse to facts alone, or indeed by recourse to evidence of any kind… [b]ecause they derive from conflicting frames" – as opposed to policy disagreements, which arise within a shared frame and can therefore be settled more easily (Rein & Schön 1993, p.148). Using slightly different terminology, Hoffman & Ventresca (1999, p.1369) seek to "explain policy debates as struggles between competing frames of meaning, embedded in competing interests and identities." Highlighting the existence of frames and analysing how they shape perceptions and practice has at least the *potential* to enable resolution of policy controversies, since without this, frames are largely invisible to their users:

> "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 organizing our preconceptions, thoughts, and actions." (Rein & Schön 1993, p.151).

This leads us to the possibility of what Rein & Schon (1993, p.150) call "*frame-reflective discourse*: a policy discourse in which participants would reflect on the frame conflicts implicit in their controversies and explore the potentials for their resolution." I hope that the case study of UK forest carbon accounting in chapter 8 provides an example of such frame-reflective discourse, with the potential to lead to constructive change and learning.

A distinct literature in the field of economic sociology also uses the concept of framing (Callon 1998c; Lohmann 2005; Callon 2009; Lohmann 2009). For Callon, framing involves "the tracing of a boundary between relationships and events which are internalized and included in a decision or, by contrast, externalized and excluded from it. ... Framing demarcates, in regards to the network of relationships, those which are taken into account

and those which are ignored." (Callon 1998b, p.15). This general concept is then applied specifically to markets via an exploration of the economic concept of an externality:

> "What the notion of externality shows, in the negative, is *all the work that has to be done, all the investments that have to be made in order to make relations visible and calculable* in the network. This consists of framing the actors and their relations. Framing is an operation used to define agents (an individual person or a group of persons) who are clearly distinct and dissociated from one another. It also allows for the definition of objects, goods and merchandise… *It is owing to this framing that the market can exist* and that distinct agents and distinct goods can be brought into play." (Callon 1998b, p.17; my italics).

Therefore framing enables markets to exist, and also creates what economists call market failures, of which externalities are a single type, by exclusion.

Accounting and accountability in all its senses is profoundly implicated in the economic concept of an externality: something (like environmental pollution) which is not calculated (*counted*) or priced in a market and hence not *taken into account* in purely economic decisions, and hence for which no one *provides an account* or is *held to account*. Therefore, using similar reasoning to Callon, one can argue that accounting plays a critical role in "all the work that has to be done" to construct a market, helping to draw the boundaries around it and define the actors (of all kinds) within it, making relations between them "visible and calculable". In other words, accounting is a key part of the framing process, with respect to the formation of markets, defining who and what they include and exclude.

Conventional accounting and conventional economic markets exclude the impacts on the global climate of what they frame as relevant actors and activities; thus climate change is regarded from an economist's perspective as "the greatest and widest-ranging market failure ever seen" (Stern 2007, p.i). Carbon accounting and carbon markets can therefore be seen as a radical re-framing of the terms of conventional accounting and economics. Re-framing the terms of the dominant paradigms that govern our daily lives is clearly an act with profound political implications, and its study should therefore maintain an awareness of the re-distributions of power that it entails.

A key point in Callon's argument is that the efficiency of markets "depends to a large extent on the socio-technical arrangements of which they are made" (Callon 2009, p.536). For Callon, markets are "fragile and complicated socio-technical artefacts" (Callon 2009, p.539), designed and constituted by a diversity of actors. Even in well-established markets, and

particularly in the case of new and experimental carbon markets, different actors frame the market in different ways, leading to disagreements over the role and purpose of the market, its boundaries and rules, including its calculative, or accounting, practices. Thus "what the market is and what it does, cannot be separated from the multiple controversies concerning it, in which as many different versions are proposed" (Callon 2009, p.540). With respect to carbon markets in particular, Callon identifies key controversies in "the framing and qualification of the goods that are traded" (Callon 2009, p.540; MacKenzie 2009), the actors involved (Lohmann 2009) and the calculative equipment that underpins measurement, equivalence and valuation activities. Carbon accounting is particularly implicated in the first and last of these issues. As Lohmann (2009, p.507) also observes specifically of carbon markets, "tensions can be expected to arise whenever a novel commodity is being created *that depends fundamentally on the development of new accounting procedures*." (my italics).

Thus far, this use of the concept of framing is relatively close to its use in the policy discourse literature, with its emphasis on the different world-views, interests and identities of diverse actors, leading to controversies that are very difficult to resolve. It is relevant because it extends the concept to a field where carbon accounting has a particularly important role – i.e. the construction of markets, both in terms of considering carbon as an externality with respect to conventional markets, and in terms of carbon accounting underpinning the creation of new carbon markets – and also because it extends it from the disciplinary arena of politics, to economics.

However, something that differentiates Callon's use of the concept of framing from its use in the policy discourse literature is his particular interest in the way in which framing deconstructs itself through what he calls 'overflowing'. This has been alluded to above, insofar as examination of the existence of externalities served to highlight the work required to frame a market. Overflowing is the necessary corollary of framing; it is what connects the outside world with the world inside the frame, which constantly challenges the apparent stability of the frame. From a research perspective, Callon suggests that one can either focus on framing as the norm, treating overflows as undesirable leaks to be contained, or on overflows as the norm, which highlights the work involved in framing, and its inevitable imperfection. His sympathies lie with the latter approach:

> "By focusing on the omnipresence of overflows, on their usefulness, but also on the cost of actions intended (partially) to contain them, constructivist sociology highlights the importance of the operations required to identify and

> measure these overflows. It also encourages us to question the mechanisms used to create frames by suggesting ways in which the social sciences might help to develop or to confine such spaces of calculability." (Callon 1998a, p.256).

Related to this, Callon invites us to consider situations as 'hot' where overflows predominate and controversy reigns, in opposition to 'cold' situations where "agreement regarding ongoing overflows is swiftly achieved. Actors are identified, interests are stabilized…" (Callon 1998a, p.261):

> "In 'hot' situations, everything becomes controversial: the identification of intermediaries and overflows, the distribution of source and target agents, the way effects are measured. These controversies, which indicate the absence of a stabilized knowledge base, usually involve a wide variety of actors. The actual list of actors, as well as their identities, will fluctuate in the course of the controversy itself and they will put forward mutually incompatible descriptions of future world states." (Callon 1998a, p.260).

If we accept Callon's depiction of economic externalities as overflows, we can likewise view carbon accounting as an effort to "identify and measure" the overflow represented by greenhouse gas emissions, with respect to the frame of conventional economic markets which treats these emissions as un-priced externalities. This is 'hot' and controversial not only because it is politically charged, involving conflicting world-views and interests of many different actors, but perhaps also simply because it is new and the knowledge base required is vast and constantly evolving. Moreover, as soon as something becomes thus identified and measured, it is thereby incorporated within a new frame – such as carbon markets – which in turn creates new overflows, which demand critical attention. As Lohmann (2009, p.502) succinctly puts it: "Every attempt to bring something 'inside' creates new 'outsides'." The 'problem' with carbon accounting that I have taken as the subject of my case study in chapter 8 is an example of such an overflow, which in turn raises moral issues of attribution and responsibility, or accountability:

> "Providing proof of the tangible existence of overflows is inextricably linked to the identification of their sources and impacts. It is not enough to demonstrate the reality and consistency of overflows; it is also necessary to establish who is responsible for them and who is affected by them." (Callon 1998a, p.257).

Therefore, in addition to providing a conceptual lens through which to view carbon accounting, Callon's concept of framing/overflowing also provides a more fundamental theoretical justification for researching carbon accounting, particularly in its application to

carbon markets, as a 'hot' situation that illustrates how markets in general are socially constructed:

> "Carbon markets thus invite us to enrich our conceptions of 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, which causes them to be in a constant state of disequilibrium, traversed by forces of reconfiguration, is not always present to the same degree but it always exists." (Callon 2009, p.541).

In summary, framing in the policy discourse literature helps to explain how common world-views are discursively constructed at the collective level, highlighting that this framing is typically invisible to its users, leading to conflicts between frames, or policy controversies, which are very difficult to resolve. Nevertheless, by paying attention to frames and discourse, the possibility arises of productive learning, re-framing and policy change. This is essentially the approach taken in chapter 6, where five key frames of carbon accounting are identified in order to highlight the overlaps and collisions between them, thus opening up a space to consider potential solutions. Likewise, chapter 7 relies on this conception of framing, using it to help understand how different communities define themselves and use discourse to claim competence in carbon accounting. This understanding of framing could be applied to any social practice and has no necessary connection to accounting. Callon's use of framing/overflowing in the context of markets and externalities, on the other hand, can be linked much more closely to accounting or calculative practices in general. It provides a critical theoretical framework for understanding climate change as a market failure, and theoretical justification for researching the role of carbon accounting in carbon markets, and therefore underpins my examination of the case study in chapter 8 in particular.

3.3. Commensuration

Another concept from sociology and sociological studies of accounting that is particularly helpful in understanding the 'work' done by carbon accounting is that of commensuration, defined as "…the expression or measurement of characteristics normally represented by different units according to a common metric." (Espeland & Stevens 1998, p.315).[12]

[12] Elsewhere, Espeland (1998, p.24) refers to "a single, common standard or unit" rather than "a common metric". However, in this thesis I have taken 'standard' as meaning a larger framework of

Commensuration is involved when emissions of different greenhouse gases are expressed in terms of their 'carbon dioxide equivalent', when emissions locally are 'offset' with reductions in emissions elsewhere, when carbon taken *out* of the atmosphere and stored, for example in tree biomass, is treated as equivalent (in the negative) to emissions *to* the atmosphere, when emissions are expressed as costs, and in countless other aspects of carbon accounting.

In their study of commensuration at work in the creation of the US sulphur dioxide (SO_2) trading scheme (which pre-dates and in many ways provided the political impetus for the creation of carbon markets – MacKenzie [2009]; Johnston et al. [2008]) Levin & Espeland (2002) distinguish between three "core dimensions" of commensuration: technical, value and cognitive commensuration. Technical commensuration is "a strategy for measuring or classifying specific characteristics or practices more accurately" (Levin & Espeland 2002, p.176). Thus, by imposing rigorous and detailed standardisation of emissions monitoring systems on the major emitters of SO_2, the US EPA enabled different rates and concentrations of pollutant emissions in different places to be expressed as multiples of a common unit (tonnes of SO_2). This was a fundamental pre-requisite for creating a tradable commodity in rights to emit pollution, as "The fungibility of pollutants as commodities hinged on people's faith that one ton of SO_2 in Chicago was really equal to a ton of SO_2 in New York. Standardized measures help produce these equivalencies and help reassure traders and regulators alike of the legitimacy of this equivalency." (Levin & Espeland 2002, pp.133–134). Technical commensuration enables value commensuration, whereby the quantitative relationship between standardised units is expressed in terms of relative monetary value. In the case of SO_2 trading, the authors point out that the attribution and convergence of prices for allowances to emit SO_2 was assisted by state intervention, for example through an auction mechanism for price discovery, as well as the price level more fundamentally being the result of government-imposed scarcity (the cap on total emissions). Finally, cognitive commensuration arises once the world-view resulting from technical and value commensuration becomes tacitly accepted and thus influences other perceptions: it involves "reclassifying the world in terms of categories that align more closely with the new metrics. These new classifications influence what we notice." (Levin & Espeland 2002, p.126). The authors argue that the creation of the SO_2 market erased distinctive differences between individual polluters and discrete chemical pollutants, as well as differences in time (by

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normative rules, perhaps but not necessarily incorporating rules that impose commensuration; hence "a common metric" is a more appropriate definition of the output of commensuration.

allowing banking of allowances, a right to emit conferred in one year could be held back for use in a different year, when conceivably the impact of the emission might be different) and space (as the market ignores local environmental impacts, treating a tonne of SO_2 the same regardless of where it is emitted).

A key contribution of the sociological literature on this subject is to highlight the power of commensuration as a concept, in part due to its long historical associations with rationality and objectivity, from Plato to rational choice theory (Espeland & Stevens 1998, pp.318–323), and also due to the power of its application in practice. Commensuration reduces quality to quantity and multiple relationships to a single expression of relative magnitude, which is thereby amenable to oversight, management and control. In other words, it is an instrument of power. Despite this, commensuration (like framing) is often invisible:

> "Commensuration as a practical task requires enormous organization and discipline that has become largely invisible to us. Commensuration is often so taken for granted that we forget the work it requires and the assumptions that surround its use." (Espeland & Stevens 1998, p.315).

This combination of power and invisibility highlights the importance of researching commensuration:

> "Investigating commensuration is important because it is ubiquitous and demands vast resources, discipline, and organization. Commensuration can radically transform the world by creating new social categories and backing them with the weight of powerful institutions. Commensuration is political: It reconstructs relations of authority, creates new political entities, and establishes new interpretive frameworks. Despite some advocates' claims, it is not a neutral or merely technical process." (Espeland & Stevens 1998, p.323).

The last point is particularly relevant to carbon accounting, as it can easily be regarded as a purely technical activity. While it is acknowledged that one aspect of carbon accounting deals with physical measurement of emissions, it must be emphasised that this is typically linked to further transformations (for example into carbon dioxide equivalents, into carbon credits, into tradable commodities and derivatives based thereon). These further transformations involve increasingly complex interactions between the 'social' (assumptions, procedures, regulatory rules, etc.) and the purely 'technical'.

MacKenzie (2009) discusses the way in which technologies (such as gas flow meters and gas chromatographs), complex technical assumptions (such as the concept of Global Warming Potential) and regulatory procedures (such as EU ETS monitoring rules and CDM accounting methodologies) come together to make two very different activities commensurable in carbon markets: emissions from a combined heat and power (CHP) plant at the University of Edinburgh, and destruction of HFC-23 at a refrigerant manufacturing plant in Zhejiang province, China. As Espeland & Stevens (1998, p.316) observe, "Commensuration is noticed most when it creates relations among things that seem fundamentally different…" In this example, commensuration and carbon accounting make the destruction of one tonne of an industrial waste gas, trifluoromethane or HFC-23, in the facility in China equivalent to rights to emit up to 11,700 tonnes of carbon dioxide in the CHP plant in Europe. The analysis highlights both the complexity of this commensuration process, and the manifold interactions between the technical and the social. Further insightful analyses of commensuration at work in carbon markets have been carried out by Lohmann (2005; 2009).

MacKenzie (2009) shows how carbon markets can only exist if very different and distant things can somehow be brought together and made 'the same'. I would argue that not only the commodification of carbon in carbon markets, but also carbon management more generally, relies heavily on commensuration. The assumptions, technologies, norms, rules and procedures that together do the 'work' of creating this equivalence deserve closer scrutiny, because of the power of these transformations, and their tendency toward invisibility as a matter of purely technical concern. As I have mentioned in chapter 2, and as I demonstrate through discussion of many empirical examples of carbon accounting in the rest of this thesis, the practice of carbon accounting has developed far in advance of academic research in recent years, involving a huge amount of diverse resources (political, technical, financial, scientific and so on), which often takes place in arenas relatively hidden from public scrutiny (such as UNFCCC expert groups, standards bodies, appointed advisory panels, etc.). At the same time, the relative novelty of carbon accounting means that it has not yet become so routine and standardised that it is completely 'black-boxed' or made "invisible by its own success" (Latour 1999, p.304). What makes carbon accounting particularly interesting as a subject of research is the relative *visibility* and state of flux of its systems of measurement and classification. This both offers rich material for research, and means that there is an opportunity for productive research in this area to have an immediate impact on practice.

Standing in direct political opposition to commensuration is what Espeland and others call the category of 'incommensurables':

> "…just as commensuration can create new relationships among disparate things, it can also undermine other relationships by transforming and transgressing the important social and cultural boundaries that mark and sustain these relationships. One way it does this is by preventing the expression of incommensurable values. … Incommensurables preclude trade-offs. An incommensurable category encompasses things, people, or experiences that are defined as socially unique in a specific way: they are not to be expressed in terms of some other category of value." (Espeland 1998, pp.28–29).

Incommensurables differ according to the symbolic importance attached to them, ranging from the trivial to what Espeland (1998, p.29; citing Raz 1986, pp.345–57) terms "constitutive incommensurables", which effectively define us as individuals or social groups – the example is given of the abhorrence a parent might feel at the idea of exchanging their children for some proffered alternative. Clearly, the notion of incommensurability is relative, not only by degree (trivial to constitutive) but also according to individual, social and cultural norms and specific context (including the level of threat posed by commensuration – perhaps something only becomes conceived of as 'priceless' when we are asked to exchange it for something else). It is also acknowledged that incommensurability can be used strategically, as a bargaining strategy to increase the compensation or exchange value of something under negotiation, as opposed to expressing a core value; likewise a claim of incommensurability can be strategically labelled as bargaining in order to downplay its political importance (Espeland 1998; Espeland & Stevens 1998).

I believe that it is helpful to combine the concepts of commensuration and framing. Commensuration seems to me to be a particular form of framing: disparate things first have to be seen as being within some kind of frame that enables relations to be drawn between them, and the frame itself will tend to prioritise certain attributes or values which are then aggregated into a common metric. Viewed in this way, 'incommensurables' are just one (extreme) example of what may happen when different frames collide. Less dramatically, different processes of commensuration taking place within different frames may lead to incompatible, incomplete, inadequate or inefficient outcomes when they interact with other frames, due to differences in key assumptions, which in turn may be related to the actors,

institutions or technologies involved. These differences may be wilful, politically or strategically motivated, or merely the random, unintended outcome of diversity in practice.

I find this combination of commensuration and framing useful when considering the 'problems' in carbon accounting discussed in chapter 8. For example, under certain conditions, landowners planting trees on historically cleared land in certain countries can generate carbon credits, under a complex process of commensuration in carbon markets. However, the identical activity carried out in the UK cannot (currently) generate similar carbon credits. This is not because any particular actor considers planting trees in the UK to have such intrinsic value that it cannot be considered commensurate with similar activities in the rest of the world; rather, I argue that it is due to the interaction between 'political' and 'market-enabling' frames of carbon accounting, which generate incompatible outcomes simply due to different framings of the issue. It is true that at one level, commensuration in this case is prevented from proceeding by a political decision on the part of the UK Government, and this decision reveals certain values, but it is not based on a value statement that UK forests are incommensurable with other forest carbon offsets *per se*. Rather, it is based on incompatible versions or framings of commensuration. From the perspective of the UK Government, UK forests are commensurate with all other greenhouse gas emissions and removals from UK territory for the purposes of meeting the country's targets under the Kyoto Protocol, but this happens to be incompatible with the landowner's view of them being commensurate with other privately appropriable and internationally tradable carbon offsets.

Espeland & Stevens (1998, p.332) speculate that "claims about incommensurables are likely to arise at the borderlands between institutions, where what counts as an ideal or normal mode of valuing is uncertain, and where proponents of a particular mode are entrepreneurial." Carbon accounting certainly fits this description, with carbon governance being characterised by the wide involvement of entrepreneurial non-state actors in addition to governments, scientific institutions and other actors (Lovell et al. 2009; H. Lovell 2010a). This leads to conflicting claims – in my view, not just about incommensurables, but simply conflicting views of commensuration, as well as other expressions of power, such as assertions of expertise, ownership and relevance. One way in which such conflicts can potentially be resolved is through the work of 'boundary organisations' that mediate between different communities, institutions or frames, such as the Intergovernmental Panel on Climate Change, which is positioned at the intersection of climate science and politics (C.

Miller 2001), trying to manage both the normative and technical judgements required to produce standardised and politically acceptable carbon accounting rules, methodologies and procedures. The concepts of 'boundary-work' and 'boundary organisations' are discussed further in section 3.5. First, however, I consider the nature of the communities involved in carbon accounting, specifically bearing in mind that they are all characterised by some form of specific expertise, which is a defining characteristic of 'epistemic communities'.

3.4. Epistemic communities

The concept of 'epistemic communities' derives from the study of policy change within the field of international relations, where its contemporary use was defined by Haas in a special issue of *International Organization* on epistemic communities in 1992 (Haas 1992b; Haas 1992a; Adler & Haas 1992). The term in fact appears to have been coined by Ruggie in 1975 and has roots in Foucault's use of the word *episteme* to refer to "a dominant way of looking at social reality, a set of shared symbols and references, mutual expectations and a mutual predictability of intention. Epistemic communities may be said to consist of interrelated roles which grow up around an *episteme*; they delimit, for their members, *the* proper construction of social reality" (Ruggie 1975, pp.569–70; italics in the original). Other influences include Kuhn's broader concept of a paradigm, or "an entire constellation of beliefs, values, techniques, and so on shared by members of a given community" which governs "not a subject matter but a group of practitioners" (quoted in Haas 1992b, p.3). Haas' definition is narrower and more specific: for him, an epistemic community is: "...a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue-area." For Haas, although an epistemic community "may consist of professionals from a variety of disciplines and backgrounds", they must have the following four key features:

> "(1) a shared set of normative and principled beliefs, which provide a value-based rationale for the social action of community members;
>
> (2) shared causal beliefs, which are derived from their analysis of practices leading or contributing to a central set of problems in their domain and which then serve as the basis for elucidating the multiple linkages between possible policy actions and desired outcomes;
>
> (3) shared notions of validity—that is, intersubjective, internally defined criteria for weighing and validating knowledge in the domain of their expertise; and
>
> (4) a common policy enterprise—that is, a set of common practices associated with a set of problems to which their professional competence is directed..." (Haas 1992b, p.3; re-formatted for clarity).

The combination of these criteria distinguishes Haas' definition from earlier variants, and is used to explain the influence in political decision-making of networks of 'experts', particularly (but not only) at the transnational level. Essentially, the argument is that when formal actors (i.e. the political representatives of nation-states) have to deal collectively with uncertain and technically complex policy challenges such as depletion of the ozone layer or human-induced climate change, they tend to rely on technical experts with recognised expertise and competence in that particular domain. If these experts are part of an epistemic community according to the above definition, their shared beliefs and common policy enterprise are likely to lead them – with or without coordination – to give similar advice to their respective national formal actors. In this way power can be transferred from the formal (government) actors to external knowledge-based elites. However, it is worth noting that the ability of an epistemic community to influence policy is constrained by various other factors: for example, Adler and Haas point out that an epistemic community is more likely to be influential at the transnational level if it is already influential at the national level (Adler & Haas 1992), and the extent to which state behaviour ends up reflecting an epistemic community's preferences "remains strongly conditioned by the distribution of power internationally" (Haas 1992b, p.7).

Haas and others stress that members of a profession or discipline do not necessarily form an epistemic community unless they share both principled and causal beliefs. The example is given of economists, who form a profession but not necessarily an epistemic community, whereas the sub-set of Keynesian economists may qualify as such (Haas 1992b, p.19). A community does not necessarily require articulated or even conscious policy intentions in order to propose convergent policy solutions: rather, "A community's advice... is informed by its own broader worldview" (Haas 1992b, p.4). This suggests that an epistemic community's common policy enterprise may arise from shared framing of problems and, therefore, perceiving (and therefore advocating) a limited range of possible solutions, based on their shared causal beliefs and common practices. Adler & Haas (1992, p.375) explicitly note that epistemic communities exert influence on policy innovation by "(1) framing the range of political controversy surrounding an issue, (2) defining state interests, and (3) setting standards." Likewise at the policy selection stage, an epistemic community can "frame the issue and help define the decision makers' interests" (Adler & Haas 1992, p.381).

While the concept of epistemic communities was originally formulated in the context of scientists influencing policy, it has been extended to other communities such as monetary experts (Verdun 1999) and accountants (Burritt 1995).

The literature on epistemic communities has been criticised for paying insufficient attention to discursive aspects of the construction of knowledge (and power). Litfin (1995, p.252) proposes that:

> "…the epistemic communities approach should be supplemented with an attentiveness to the ways in which discursive practices promote specific narratives about social problems. Whereas an epistemic communities approach emphasises agents of information, a discursive approach stresses frameworks of meaning."

Like Litfin (1995, p.253), I would like to steer a middle course between excessively agent-centred or discourse-centred approaches to epistemic communities: agents are neither totally conditioned by, nor fully independent from, their social settings. The policy discourse concept of framing is therefore usefully combined with attention to how epistemic communities construct knowledge and power relationships through discursive acts.

A final point that is worth noting from this literature is the importance of what we might describe as techniques of demonstrating and defining authority in order to provide access to the policy arena and/or to block the access of others:

> "The epistemic community members' professional training, prestige, and reputation for expertise in an area highly valued by society or elite decision makers accord them access to the political system and legitimize or authorize their activities. Similarly, their claims to knowledge, supported by tests of validity, accord them influence over policy debates and serve as their primary social power resource. At the same time, the professional pedigrees and validity tests set the community members apart from other social actors or groups and not only serve as a barrier to their entry into the community but also limit the influence that these other actors or groups might have in the policy debate." (Haas 1992b, p.17).

The latter activity, setting a community apart from other actors or groups and enhancing the community's influence at the expense of others, is considered more closely in the context of boundary-work in the next section.

3.5. Boundary-work

The concept of 'boundary-work' originates in the sociology of science, where it was first formulated to describe strategic behaviour or "rhetorical style" employed by scientists with the aim of creating distinctions between science and non-science (Gieryn 1983, p.782). By drawing attention to the discursive activities by which boundaries are established, maintained and adapted over time, difficulties in identifying essential characteristics of science are circumvented, and the social construction of such characteristics is explicitly acknowledged. It was recognised at an early stage that the concept of boundary-work could be applied to other demarcations, for example between disciplines or professions. Gieryn identifies three generic rhetorical devices relevant to the activity of "professionalization":

> "(a) when the goal is *expansion* of authority or expertise into domains claimed by other professions or occupations, boundary-work heightens the contrast between rivals in ways flattering to the ideologists' side; (b) when the goal is *monopolization* of professional authority and resources, boundary-work excludes rivals from within by defining them as outsiders... (c) when the goal is *protection of autonomy* over professional activities, boundary-work exempts members from responsibility for consequences of their work by putting the blame on scapegoats from outside." (Gieryn 1983, pp.791–2).

Reacting to the potential instability created by boundary-work (blurring of boundaries, precisely due to their uncertain and ambiguous social construction), Guston (2001) turns his attention to "boundary organizations" as linking and stabilising institutions. A boundary organisation draws its membership from actors from both sides of the boundary (traditionally, between science and politics), but importantly also includes "professionals who serve a mediating role" (Guston, 2001: 401). Being thus constituted enables boundary organisations to perform a unique role that would be difficult or impossible for organisations based on either side of the boundary. In contrast to the oppositional rhetoric identified by Gieryn above, Guston (2001) and others (e.g. Jasanoff [1990]; C. Miller [2001]; Shackley & Wynne [1996]) find that boundary organisations, and other associated devices, can serve to reconcile tensions and lead to more productive policy-making.

Originally developed in the context of US politics and science, Miller extends the concept of boundary organisations to the international sphere, specifically exploring the institutions associated with providing scientific advice on climate change to international policy-makers and drawing attention to the 'hybrid' nature of such organisations, defined as "social constructs that contain both scientific and political elements, often sufficiently intertwined to

render separation a practical impossibility" (C. Miller 2001, p.480). According to Miller, 'hybrid management' consists of putting such hybrids together (hybridization), taking them apart (deconstruction), establishing and maintaining boundaries (boundary work) and coordinating activities taking place in multiple domains (cross-domain orchestration) (C. Miller 2001, p.487).

3.6. Summary

In this chapter I have shown that my approach to conceptualising carbon accounting can clearly be located within the 'alternative' paradigm of accounting theory, as opposed to the 'mainstream', positivist paradigm. Within this, I take an interpretive approach to the initial problem of understanding carbon accounting as a socially constructed reality. However, the two-way connection between carbon accounting and the physical reality of climate change means, for me, that I agree with Dillard (1991, p.25) that "We can no longer be satisfied with only interpreting the world; we must become an active catalyst for change." This aligns me with critical theory in general, but I have been selective in my use of concepts from both German and French schools of critical theory, rather than adopting a particular theory or theorist as a whole. These key concepts are framing, commensuration, epistemic communities and boundary-work.

A key difference between the idea of framing as it is used in the policy discourse literature and the economic sociology literature is that the former focuses on *multiple* frames and how this leads to conflict, while the latter tends to consider a *single*, dominant frame (e.g. 'the market'), with an interest in what this excludes (in Callon's terminology, 'overflows'). As I developed my theoretical understanding of carbon accounting through the grounded theory approach discussed in chapter 2, something that continually struck me was the way in which carbon accounting was seen completely differently by different groups or communities of practice. Rarely did this seem to be a conscious response of opposition to a dominant framing; rather, it seemed to be simply a reflection of that community's pre-existing ways of thinking and acting. Therefore I found the concept of (multiple) framing from the policy discourse literature to be particularly useful in formulating the theory of five key frames of carbon accounting which is developed in chapter 6. This in turn can be linked to the notion of multiple epistemic communities, with boundary-work as the way in which conflicts between multiple frames and communities can potentially be resolved, which I explore in chapter 7.

However, when it came to thinking about the effectiveness of carbon management, and carbon markets in particular, Callon's version of framing became more useful. A carbon market such as the EU ETS is no longer just one conceptual framework jostling against others: it is an entrenched, institutionalised reality, governing roughly half of Europe's greenhouse gas emissions and resulting in financial flows of billions of dollars. It therefore becomes extremely relevant to look at what such framings leave out, and why, and the case study in chapter 8 does exactly this. Why is it that certain activities that reduce emissions are rewarded in carbon markets, whereas others are not? Callon's concept of framing/overflowing as mutually inseparable operations suggests that such exclusions or overflows are inevitable, but on the other hand, exactly where the line is drawn is open to debate. This is where research into the 'problems' of carbon accounting can be particularly productive.

One consequence of my selective approach to theory is that it begs the question why I have included these particular concepts and not others. The same question ought to apply, but the choice is perhaps more easily accepted, if I had selected and used only a single theory or theorist. On the question of inclusion I justify my approach on the basis of grounded theory: these concepts arose from and made sense in the iterative process of "constant comparison" and "theoretical sampling" of empirical data on the actual practices of carbon accounting. I think that they are sufficient in order to provide a useful contribution to knowledge in response to the research questions that I have posed; in other words, in grounded theory terms I believe they meet the requirement of "category saturation". However, applying other theoretical frameworks to the same empirical data could lead to further, different insights. For example, I have not explicitly considered actor-network theory, despite drawing on two of its main theorists (Callon and Latour). A key concept in actor-network theory is that networks or systems are best understood as comprising not just the human actors within them but a variety of non-human 'actants' as well. In the case of carbon markets, this would include technologies such as meters, data loggers and a vast panoply of emission producing, reducing, measuring, recording and verifying equipment. I am certain that these non-human actants play a key role in how carbon accounting is operationalised in practice. For example, I once observed a case in which the accounting of emission reductions from a CDM project was delayed for several months because of a (footnoted) requirement in the relevant CDM methodology that the monitoring equipment had to comply with European Norm *EN 14181 Stationary source emissions – Quality assurance of automated measuring systems*. This in turn imposed a requirement that the project's gas flow meter had to be calibrated in a

laboratory accredited under EN 14181, but there was no such accredited laboratory in the country, so the gas flow meter had to be shipped to an accredited laboratory in Germany for calibration tests and shipped back again before emission reductions could be 'counted'. Examining cases like this from an actor-network perspective could provide an interesting account of how the spread of carbon accounting from developed to developing countries has led to unintended consequences in the expansion of other standards and procedures. However, this is beyond the scope of my research questions, and I believe the four key theoretical frameworks outlined in the previous sections offer a better fit with the empirical material examined in this thesis.

Finally, I acknowledge that some of the concepts I have used – especially framing – are similar to a variety of other terms used by other authors. This begs the question of why I did not use these alternatives, and more importantly, whether the alternatives offer subtle differences which might be advantageous in explaining the practice of carbon accounting. For example, consider this description of 'ideology' from Espeland (1998, p.43):

> "Ideology structures consciousness. It simultaneously offers a way of seeing and not seeing, an elaboration and defense of some relations that inevitably render others inchoate, invisible. …[It can be characterised as] the collective, defined system of meanings, values, or beliefs of a particular social group that expresses a "worldview." …Among other things, ideology is practical work that people routinely do when they perform their jobs, explain their actions, or describe themselves to themselves or to others."

At face value, this sounds the same as the concept of framing in the policy discourse literature. However, I would not substitute the term 'ideology' where I have used 'framing', because to me, ideology implies a particular kind of framing of society at large which emphasises and actively seeks to control or structure the power relations between different social groups. I edited out two sentences from the previous quotation which make this distinction clearer: "Ideology is part of the struggle to control the cultural terms by which power is legitimated and the world is ordered" and "It is power expressed by agents, by people with intentions in specific, historical contexts." (Espeland 1998, p.43). Framing, on the other hand, is a much broader concept. It can range from the trivial (e.g. a chance encounter with a friend is framed by our shared past experiences as well as the context of the occasion on which we meet) to the all-encompassing, politically charged notion of ideology. Therefore it is not interchangeable, and I believe the same would apply to other similar terms, such as Bourdieu's notion of 'habitus' or "the durable set of dispositions which we carry around in our heads as social actors as a result of our social experience in certain kinds

of backgrounds and circumstances" (Layder 2006, p.195). Nevertheless, these alternatives could provide different insights, which, however, I have not explored in the present thesis.

4. A review of carbon accounting in the social and environmental accounting literature

A paper based on this chapter has been published in a special issue of Social and Environmental Accountability Journal *(Ascui 2014).*

4.1. Introduction

Shortly before I started my research for this thesis in 2008, Gray et al. (2007, p.17) had remarked on the "almost complete absence of any "carbon accounting" in the social accounting literature." The same paper elsewhere describes 'social accounting' as the study of "accounts of social and environmental interactions" (Gray et al. 2007, p.8), and I will henceforth use the term 'social and environmental accounting' (SEA) to denote this same broad area of academic research, inclusive of related terms such as sustainability accounting and accountability (for overviews of the development of this field of research see Mathews [1984]; Gray et al. [1993]; Mathews [2000]; Bebbington & Gray [2001]; Mathews [2004]; Thomson [2007]; Owen [2008]; Parker [2011b]; Parker [2011a]; Gray & Laughlin [2012]). SEA research represents the most obvious disciplinary locus of academic interest in carbon accounting for this thesis, situated as it is within the accounting and finance subject area of a business school.

Gray et al. (2007, p.17) went on to predict "an upsurge in interest in carbon accounting and, somewhat belatedly, an academic literature on it", thanks to the "largely unprecedented adoption of "carbon" as a focal point by both business and policy [communities]". The larger point they were making was that SEA accounting research typically follows current practice, rather than leading it. This is definitely true of carbon accounting, and I will discuss the origins of carbon accounting as practice, as well as its study in various other disciplines, in chapter 5. The present chapter will demonstrate that, as predicted, an explosion of academic research into carbon accounting took place from 2008, led by special sections on the subject in *European Accounting Review* (2008) and *Accounting, Organizations and Society* (2009), followed by special issues of *Accounting, Auditing and Accountability Journal* (2011) and the *Journal of Cleaner Production* (2012). While some of the researchers involved would not necessarily identify themselves with the SEA research community, many would, and the body of research as a whole can be seen to fit within the scope of the SEA field.

While I will restrict the scope of this chapter to reviewing the relevant SEA literature, the observation made by Gray et al. in 2007 could equally have been made of the business and management literature more broadly at the time. While the terminology of carbon footprints, offsets and trading had begun to enter some of the organisational strategy literature (e.g. Hoffman 2005; Hoffman 2007; Porter & Reinhardt 2007), this research did not focus on carbon accounting specifically as its subject. A few early empirical studies of life cycle greenhouse gas emissions from various products can be found in what could be regarded as a branch of the operations management literature (Gielen et al. 2002; Reijnders & Huijbregts 2003; Karlsson & Pigretti Öhman 2005; Reijnders & Huijbregts 2007), but this emanates mainly from engineering and environmental sciences, rather than business and management (e.g. Gielen, Reijnders and Huijbregts all worked in environmental science departments, Karlsson was an engineer within an institute for environmental economics). These exceptions highlight the general rule: until 2008, carbon accounting was conspicuous by its absence in academic business and management research.

However, it should not be assumed that this absence holds true of other disciplines. Economists, lawyers, political scientists, energy and forestry researchers have all made considerable contributions to carbon accounting research, from well before 2008 (see for example Marland & Rotty [1978]; Marland & Rotty [1979]; Lashof & Ahuja [1990]; Gustavsson et al. [2000]; Marland et al. [2001]; Sedjo & Marland [2003]; Subak [2003]; Locatelli & Pedroni [2004]; Yamin & Depledge [2004]). While this chapter aims primarily to situate the rest of this thesis in relation to relevant research on carbon accounting within the discipline of business and management, it also aims to highlight the gaps in relation to both carbon accounting in practice, and carbon accounting as it is viewed by other disciplines. These other perspectives are discussed further in chapters 5 and 6.

This chapter shows that the SEA literature on carbon accounting is already substantial, 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, research attention has not been spread evenly between these categories, with the bulk of attention going to carbon management accounting and corporate carbon disclosure, reflecting SEA's preoccupation with the corporation as the relevant accounting entity (Lehman 1999). There is considerable scope for further research, particularly on how carbon accounting either enables or inhibits

the effective functioning of carbon markets, as well as more interdisciplinary research and research grounded in practice – to which this thesis contributes. In addition to situating the thesis within the discipline, this literature review demonstrates how carbon accounting, as a new set of calculative practices at the margins of accounting (Miller 1998), is being framed as an accounting 'problem' by academic researchers and gradually incorporated within the boundaries of SEA research. However, it also points to the potential for carbon accounting to push the boundaries of SEA research outwards, towards more engagement with other disciplines and with accounting entities other than the corporation.

The chapter is structured as follows. Section 4.2 briefly describes the review method. Section 4.3 reviews the SEA literature on carbon accounting, organising this within a subjective classification framework. Section 4.4 then provides some observations on the reviewed literature as a whole, and considers its omissions and scope for further research.

4.2. Review method

In keeping with several well-regarded reviews of the SEA literature (Parker 2005; Owen 2008; Parker 2011b) I included four leading interdisciplinary accounting journals within the scope of this 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 et al. (2011; 2013). I have thereby included all of the top five and seven out of the top ten journals with the most publications on EMA (Schaltegger et al. 2013, p.14).

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.[13] As the term "carbon accounting" is not necessarily used by all commentators on the subject, it was supplemented

[13] See http://www.unisa.edu.au/Research/CAGS/APCEA/Journal/ (accessed 29 April 2013).

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 and therefore including some later publications. The results are summarised in Table 4. 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.

I read and summarised each paper, and then used these summaries (together with tags and notes in Mendeley) 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 my 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 further objective was to identify potential gaps in the literature. Identifying gaps is problematic for a new field such as carbon accounting, as it assumes some conception of the 'whole', which may not yet have been defined, or which may be constantly expanding or changing. I develop an expanded definition and conceptual framework for carbon accounting in chapters 5 and 6 that, whilst inevitably still incomplete, can nevertheless claim to be more comprehensive than previously published equivalents. In order not to pre-empt this discussion in the narrative sequence of this thesis, I have restricted my observations in the current chapter to the more obvious gaps which are suggested by the relative volume of publications in different areas of the reviewed literature, and the disciplinary characteristics

of those publishing in the field. Nevertheless, a certain amount of pre-emption is inevitable in this chapter, as I have had to include in my review of the literature a brief summary of a paper based on part of chapter 5 and chapter 6 (Ascui & Lovell 2011), as well as another (Ascui & Lovell 2012) based on chapter 7. I will return to the question of gaps and scope for further research in my final conclusions, chapter 9.

Any review such as this inevitably has to draw boundaries and leaves out some relevant material, even within the already narrow scope of the selected journals. 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. My subjective opinion is informed by my practical experience at the leading edge of developments in carbon accounting, as outlined in section 2.2.1 of chapter 2.

4.3. Overview and classification

The literature on carbon accounting found in the target journals is summarised in Table 4. 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, as they deal with sociological aspects of carbon markets in general, rather than just 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" (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 et al. 2008; Freedman & 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 (2011a) on corporate carbon reporting in Australia; Lodhia (2011b) which points out that unlike voluntary social and environmental reporting, carbon pricing not only involves corporations providing an account of their actions but also enables them to be held to account; 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 includes empirical evidence. Nevertheless, it serves as one useful dimension for classification, broadly consistent with Mathews' (1997, p.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.

Table 4: Summary of carbon accounting research in the SEA literature

Journal	Count	Cross-check	Discussions *about* carbon accounting	Carbon management accounting	Carbon disclosure and reporting	Carbon financial accounting	Carbon accounting education
EAR	2	2	Bebbington and Larrinaga-González 2008		Kolk, Levy, and Pinkse 2008		
AOS	5	3	Hopwood 2009; MacKenzie 2009; Lohmann 2009	Engels 2009		Cook 2009	
AAAJ	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		
JCP	64	0	Schaltegger and Csutora 2012; Stechemesser and Guenther 2012; Burritt and Tingey-Holyoak 2012; Ascui and Lovell 2012; Mózner 2013	55 papers (25 cited in section 3.2)	Gallego-Álvarez, Rodríguez-Domínguez, and García-Sánchez 2011; Dragomir 2012; Sullivan and Gouldson 2012; Pellegrino and Lodhia 2012		
CPA	2	0				Mete, Dick, and Moerman 2010; Moore 2011	
AF	1	1			Andrew and Cortese 2011		
SEAJ	1	0					de Aguiar and Fearfull 2010
JAPCEA	3	1			Chatterjee 2012; Qian 2012	Zhang-Debreceny, Kaidonis, and Moerman 2009	
Total	**89**	**11**	**13**	**56**	**15**	**4**	**1**

Note: 'Cross-check' is the count in Stechemesser and Guenther (2012).

4.3.1. 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 broader 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 & Larrinaga-González (2008) provide an excellent introduction to research into corporate accountability to stakeholders for their climate change impacts. They provide an initial overview of the science of climate change and the policy responses to climate change, including markets which have been set up with the aim to internalise (some measure of) the social cost of carbon, such as the EU Emissions Trading System (EU ETS). They rightly point out that this has financial implications for affected firms, which need to be considered in the production of financial accounts. They then consider in more detail three accounting implications of global climate change for companies: financial accounting of emission allowances under emissions trading schemes, where they review the debate around whether and how to recognise emission allowances and corresponding obligations to surrender allowances in the financial accounts; accounting and reporting for climate change risks to corporate performance, where they note the growing demand from various stakeholders for non-financial accounting and reporting "of and about GHG emissions" (ibid: 707); 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 & 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 in the first place 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." (Hopwood 2009, p.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 & 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. Interestingly, MacKenzie only identifies the latter as suited to researchers in accounting, with the former being "a natural question for the social studies of science and technology" (MacKenzie 2009, p.441). 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. The point of paying attention to such details is to expose the ways in which they may be socially constructed – influenced by a variety of social, political and economic influences, which being made visible, may be challenged. 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 ETS in 2005 (discussed further in Cook [2009]). The issuance (in December 2004) and subsequent withdrawal (in 2005) of accounting guidance by the International Financial Reporting Interpretations Committee (IFRIC) highlights the limitations of attempts to classify a new construct such as carbon allowances simply by analogy to other, previously classified items – a debate which continues unabated today (Autorité des normes comptables 2012; EFRAG 2012). 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” (p.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) emphasise 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 (concluding it could be crippling if absorbed by the company, but much less impactful if passed on to consumers), 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” (p.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, more encompassing '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 (p.980). The authors seek to make sense of this diversity through use of the concept of framing, identifying five key frames of reference 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" (p.982). Finally, they call for carbon accounting to be recognised 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" (p.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" (p.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) (pp.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" (p.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 & Wittneben 2011, p.1032). Finally, they argue that other ways of reducing emissions, such as more traditional command-and-control regulation, may be more effective and efficient at reducing emissions than more market-based measures that rely on carbon accounting.

McNicholas and Windsor (2011) discuss carbon accounting towards the end of a broader critique of the "financialisation of the atmosphere" (p.1074), arguing that this is merely an

extension of the financialisation of capital, which in turn they link to the global financial crisis of 2008. 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 challenge 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 (c.f. Ascui and Lovell 2011; Bowen and Wittneben 2011; Stechemesser and Guenther 2012), 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) (Schaltegger & Csutora 2012, p.4). They break these down further into essentially 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. Interestingly, they relate the first two of these activities to the critical SEA perspective (and 'accounts of un-sustainability') and the second two to "pragmatic sustainability accounting research" (p.7) and 'accounts for sustainability improvements'. Amongst other tools for the latter, they discuss ecological investment appraisal, carbon planning and ecological budgets (physical carbon accounting methods) and their monetary equivalents in terms of cost and profitability assessment. The authors go on to 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. They 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 fact that indirect emissions, particularly in supply chains, require new hybrid physical and monetary accounting methods. They conclude that "Because most activities are directly or indirectly related to carbon emissions, corporate carbon accounting is not just a topic for the sustainability department" (Schaltegger and Csutora 2012: 13): many corporate functional units are involved. This leads the authors to 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 literature 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 (via Google Scholar and a search of accounting companies' websites). First of all, however, they make it clear that they identify carbon accounting as a sub-set of environmental accounting, with similar external/internal, monetary/physical and voluntary/regulatory dimensions. While applying primarily to organisations, they acknowledge that environmental accounting may also be applicable at national, regional, firm, plant and product levels. They observe an increasing trend in publication, with most papers being 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%), with authors mainly from the USA (30%), Australia (16%) and the UK (15%) (p.19). It is interesting to see such a high proportion of authors from the USA, in contrast to a lower proportion in the SEA literature (Parker 2011b). 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 several papers mentioned elsewhere in the present review (Bebbington & Larrinaga-González 2008; Kolk et al. 2008; Ascui & Lovell 2011; Bowen & Wittneben 2011). Using citation analysis to identify clusters of similar publications, they identify four key scales of carbon accounting: organisational (35% of publications), national (28%), project (25%) and product (9%) scales. Nearly 60% focussed on physical information, 20% on monetary and 22% on a combination of the two.

The authors conclude that an over-arching definition of carbon accounting is possible: "Carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems", yet at the same time they acknowledge that "researchers from different disciplines, but even within one research field, have a different understanding as to what carbon accounting is" (Stechemesser & Guenther 2012, pp.35–36).

Burritt and Tingey-Holyoak (2012) ask whether there is a gap between academic and practitioner accountants in relation to carbon accounting. They propose a model in which knowledge is generated by academics and then applied by practitioners, with the transfer or knowledge typically occurring via a smaller sub-set of either academics or practitioners who act as intermediaries, rather than being directly disseminated. Interestingly, this seems to preclude knowledge being generated by practitioners and flowing in the opposite direction to academics, which seems quite applicable to carbon accounting, which has a much longer history in practice than in the academic (accounting) literature (Ascui & Lovell 2011). Analysing survey responses from 12 accountancy firms in South Australia, Burritt and Tingey-Holyoak (2012) generate some preliminary observations that these firms are using only a few out of a set of 20 'known' sustainability accounting instruments. The main carbon accounting instrument used (by 1 firm) was emission reporting, driven in this case by client demand. 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 1992b; Haas 1992a; Adler & Haas 1992), boundary-work and boundary organisations (Gieryn 1983; Guston 2001; C. 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 then given, drawn from sources such as professional body publications and interviews with accountants, of

discursive strategies being employed to re-frame carbon accounting, relating it to existing competence in financial and management accounting, and warning of dire consequences if accountants are not involved (Ascui & Lovell 2012, p.55). 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 (e.g. the radically democratic carbon disclosure practised by the organisation Sandbag) 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 Mózner (2013) was difficult to classify. It is largely an empirical study, in this case 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 (where it is pointed out that even concepts such as 'direct' and 'indirect' emissions have different meanings for different types of carbon accounting), measurement units, and degree of decomposition into component parts.

4.3.2. 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 et al. 2011; Schaltegger et al. 2013).

JCP 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 et al. (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, on emissions associated with medical products) and 2007 (Reijnders and Huijbregts, 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 & Meil 2009) and water supply (Friedrich et al. 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. For example, Reijnders and Huijbregts (2003; 2007) demonstrate that considerable variation in estimates of life cycle emissions of biofuels (from negative, i.e. net sequestration, to highly positive) may be obtained, depending on choices over whether to include biogenic emissions as well as fossil fuels, and if so, according to various key assumptions about biogenic emission factors. Similarly, Salazar and Meil (2009) examine the life cycle emissions from a conventional timber frame house (combined with other conventional non-wood materials), and a 'wood-intensive' house that maximises the use of wood materials, finding that the wood-intensive house has a considerably lower life cycle carbon balance than the conventional house, but that both estimates are sensitive to numerous assumptions and calculation choices. Sjølie (2012) use LCA to evaluate the impact of substituting coal in cement manufacturing and traditionally produced charcoal with charcoal briquettes and powder derived from sawmill wastes in Tanzania, again finding that the results are significantly influenced by assumptions such as whether or not the source biomass is considered carbon neutral, with the implication that the gains from product substitution are greatest in areas where wood harvesting is not sustainable. 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 et al. 2011), a Norwegian county (Larsen & 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 et al. 2010) or land use change in general (Ponsioen & 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 in 2010 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. The author points out that "there is knowledge gap between the types of information required and the usefulness of this information for carbon management. That is to say that there has been little evidence obtained about what type of information should be collected, and why this information should be collected for carbon management" (p.84). 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. Bradley, Druckman, and Jackson (2013) put forward a model for estimating emissions for small and medium-sized enterprises from higher-level data, with a case study demonstration based on the hospitality industry in Southampton.

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).

Rietbergen & Blok (2013) examine the impact on total emissions of a Dutch government green procurement programme known as the CO_2 Performance Ladder, which involves independent audits of supplier compliance with one of five possible 'maturity levels' for carbon management. Higher maturity levels give suppliers a competitive advantage in government procurement tenders. As levels 3 to 5 require emissions reporting and independent verification, the authors were able to gather and compare emissions data for 110 companies for 2009 and 2010, observing a reduction in emissions for scopes 1, 2 and 3. However, the authors note that the data could be influenced by various exogenous factors, such as reduced economic activity over that period, changes in rules for accounting green

power purchases, changes in organisational boundary, accuracy and completeness, double-counting of Scope 3 emissions, use of different carbon accounting standards, use of different or updated emission factors and differences in verification, in addition to underlying uncertainties in the collected and extrapolated emissions data. The authors also found deficiencies in the extent to which targets set by companies met 'SMART' (Specific, Measurable, Appropriate, Realistic and Timed) criteria. Nevertheless, the authors estimate that the targets add up to overall reductions (if fully achieved) against a business-as-usual scenario of 0.7-2.4%/year. The authors acknowledge that the study cannot determine the extent to which the targets are driven by the CO_2 Performance Ladder as opposed to other possible drivers, such as general corporate social responsibility objectives.

Engels' (2009) contribution to AOS promises to be a study of "how companies learn to account for carbon" (p.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.

4.3.3. 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 et al. (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). In their view, carbon accounting is a "more precise, formal but narrower activity concerned with quantifying emissions that can be bought and sold in accordance with a particular set of legal standards and limits" (p.725), as opposed to carbon disclosure which includes information on a broader range of climate-related activities. They draw on the concept of institutional entrepreneurship to help explain the emergence of carbon disclosure as a new form of carbon or climate governance, noting the use by environmental NGOs of investors as way of

leveraging ‘strategic power’ (Levy & Scully 2007) to achieve their objectives. Importantly, they highlight the critical reliance of carbon accounting on commensuration (Espeland & Stevens 1998), pointing out that this process is both technical and political in nature. However, commensuration is a necessary but not sufficient condition for institutionalisation of an effective carbon governance regime. The authors then show, through an analysis of 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 et al. 2008, p.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. These results would also seem to be consistent with legitimacy theory.

Cooper and Pearce (2011) examine climate-related performance measurement and reporting from English local authorities, through a combination of documentary analysis and interviews. This included two indicators which required measurement of a local authority’s carbon footprint, relative to previous performance. They find that “local performance frameworks are perceived as a narrow, bureaucratic procedure focussed on the legitimising of decisions and more easily quantified immediate and intermediate outcomes. Performance may, therefore, be misrepresented and policy design have unintended consequences” (p.1112). 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. Finally, they note that a change of government and resulting decentralisation policy, combined with sharp budget cuts, calls into questions whether national carbon reduction targets will be achieved, concluding that "it is commonsensical that this [climate change] should remain a central government responsibility" (p.1114).

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. This appears to be driven by investors' beliefs that climate change represents a material, salient risk that their clients want them to manage. Interestingly, all the investors interviewed appeared to take an activist approach, using private climate change reporting as a way of achieving change in investee companies' behaviour (p.1134). In keeping with this, investors want climate change strategy to be genuine, deep-seated and embedded in corporate strategy. However, the authors note the "complete absence of any ethical discourse" (p.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 GHG Protocol). It is perhaps doubtful whether these are all really comparable: for example, PAS 2050 (BSI 2008) is a specific standard for measuring life cycle emissions of goods and services, whereas input-output analysis is a general economic method rather than a carbon accounting standard. What is clear, however, is that there is much scope for misrepresentation in the reporting of emissions intensity (e.g. emissions per unit of revenue). 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 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 CPA Australia's views "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" (p.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. The authors also find evidence that the nature of the entity being audited and uncertainty of the data may influence perceptions and degree of expectation gaps. In keeping with other studies, they 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 indeed disclosing more greenhouse gas emissions information, and signalling this through increased use of highlighting devices, particularly for non-intensive sectors. More disturbingly, the author also finds an increase in emphasis on symbolic information, associated with a pragmatic approach to seeking legitimacy, particularly for non-intensive sectors (dominated by

financial services). 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 legitimation 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 (Fortune 500) 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 argues that it is important for research on European companies to start using more accurate empirical data to assess corporate environmental performance, as opposed to proxies such as external ratings or perceptions. As greenhouse gas emissions are now regularly reported in sustainability reports as well as through initiatives such as CDP, the question arises as to whether such data are sufficiently credible and relevant to assess environmental performance. The author finds significant gaps and shortcomings in the data presented by the five companies, as compared with the requirements of the GHG Protocol (WBCSD & WRI 2004), 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, particularly in areas such as supply chain emissions, 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" (p.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, and the ultimate effect of this on climate-related decision-making. 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" (p.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.

4.3.4. 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 define and 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." (ibid: 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" (p.223).

In JAPCEA, Zhang-Debreceny, 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 SO_2 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 also 'entitles' the firm to emit.

4.3.5. Carbon accounting education

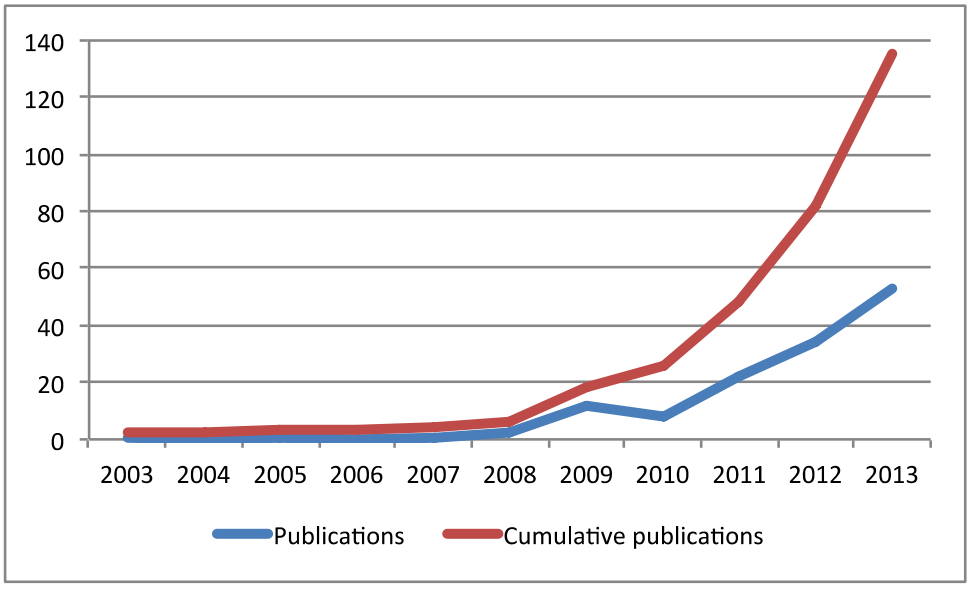
De Aguiar and Fearfull (2010) propose using carbon disclosure to "spearhead emancipation from superficial educational accounting practices" (p.64), based on the premise that understanding corporate contributions to climate change is currently insufficiently covered within accounting, business and management 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.

4.4. 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 5, which includes in the numbers 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 et al. 2011; Schaltegger et al. 2013), indicating that carbon accounting is likewise a young discipline with considerable growth potential.

Figure 5: 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% 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, even three decades into its development (Mathews 1997, p.503; Parker 2005, p.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 2011b). 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 2007b), 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 2008a; 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 et al. 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.

4.4.1. Gaps and directions for further research

In purely numerical terms, this review has shown that the SEA literature on carbon accounting is dominated by empirical carbon management accounting research (56 papers) published almost exclusively in JCP (55 papers). With few exceptions, this literature focuses on the application of specific methods of carbon accounting and tends not to provide critical or interpretive reflections on what carbon accounting is, or who it might involve. It is, however, interested in the question of *how* it should be done, and the implications of different methods. The unit of analysis ranges from products and processes to organisations, supply chains and, sometimes, whole sectors, regions or countries (although products and

processes dominate). The focus on specific methods and situations in this literature often serves to highlight accounting-related problems in carbon management, such as the possibility that biofuels could be considered to have either positive or negative emissions over their entire life cycle, depending on various key assumptions (Reijnders & Huijbregts 2003; Reijnders & Huijbregts 2007), or the fact that Japan could be over-estimating carbon storage in its national account by 23 $MtCO_2e$ (Gielen et al. 2002). There is a notable lack of papers in this category engaging directly with methods of carbon accounting in carbon markets. The methods applied are predominantly those of life cycle assessment (around 41 papers) and input-output analysis, neither of which tend to be used in carbon markets, whether in accounting for emissions of participants in emissions trading schemes, or in accounting for emission reductions under various offsetting mechanisms.

The next largest category is carbon disclosure and reporting (15 papers), which is spread more evenly between the journals, with the largest group being in AAAJ (7 papers). The focus here is nearly always on disclosures by corporations of greenhouse gas emissions and related information, although one example (Cooper & Pearce 2011) examines reporting by local authorities and several papers are also interested in the users (Solomon et al. 2011; Haigh & Shapiro 2012; Sullivan & Gouldson 2012) or assurers (Green & Li 2012; Chatterjee 2012) of this information. This is a fast-changing area: the number of companies voluntarily reporting to the Carbon Disclosure Project (CDP) has grown from 235 in 2003 to 4,112 in 2012, and the questionnaire format is constantly being refined, meaning that conclusions such as those made by Kolk et al. (2008), which were based on data from 2007, a year in which only 1,449 companies reported, require periodic re-examination.[14] Standards for carbon disclosure and reporting are constantly being introduced or updated – for example, of the papers in this review only Schaltegger & Csutora (2012); Haigh & Shapiro (2012); Ascui & Lovell (2012); and Sullivan & Gouldson (2012) mention the Climate Change Reporting Framework first published by the Climate Disclosure Standards Board (CDSB) in 2010. Section 7.4 of chapter 7 examines the key stakeholders involved in the CDSB as an organisation, and specifically the role of accountants in the development of the Climate Change Reporting Framework. Further research could examine the extent to which companies actually use this reporting framework, and whether the information thus produced is decision-useful (Sullivan & Gouldson 2012). The CDSB's recent decision to broaden the scope of its reporting framework to include forest commodities and water (CDSB 2014) is also worthy of further attention, particularly in the context of renewed efforts to account for

[14] https://www.cdp.net/en-US/Results/Pages/overview.aspx (accessed 7 January 2014).

'natural capital' and ecosystem services more generally (Natural Capital Committee 2013; Plan Vivo 2013), and likewise the UK's recent introduction of mandatory carbon reporting for listed companies (Defra 2013) should provide fertile ground for further research into the efficacy, comparability and decision-usefulness of carbon disclosures.

A preoccupation with the corporation as the unit of analysis is natural enough in the category of carbon financial accounting (4 papers), which by definition concerns the financial accounting treatment of emission allowances and liabilities under emissions trading schemes, which typically cover large energy-intensive corporations. Nevertheless, even here there would be further scope to examine the implications for other kinds of reporting entity: for example, the EU ETS includes, in addition to corporations, a number of universities, healthcare organisations and other public sector organisations. This is an area where accountancy researchers can bring undisputed expertise to help develop practical solutions to an identified problem, where the lack of an accepted international standard creates significant differences in financial reporting between companies (PricewaterhouseCoopers & IETA 2007a; Deloitte 2007; KPMG 2008; Cook 2009; MacKenzie 2009; Lovell et al. 2010; Lovell et al. 2013). There is equally a need for more sociologically-oriented research to help understand and theorise the standard-setting process and the role of different agents and institutions within this. Chapter 7 provides a contribution to this, as it explores the ways in which practicing accountants have sought to extend their claims of competence from a field in which they have undisputed expertise (carbon financial accounting) to other forms of organisational carbon accounting, where relevant expertise is also claimed by a range of other actors (Ascui & Lovell 2012, p.54).

Apart from these papers on the financial accounting implications of carbon markets, the relative shortage of SEA literature dealing with the specifics of accounting in carbon markets is striking (notable exceptions being Lohmann [2009]; MacKenzie [2009] and Ascui & Lovell [2011]). Carbon markets are brought into existence via a multitude of calculative practices through which physical emissions of greenhouse gases, reductions in emissions against hypothetical baselines, 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 et al. 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 & Guignon 2012; Peters-Stanley & Hamilton 2012). 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).

At present, most of the academic research in this area 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; Susan Subak 2003) or *Global Environmental Politics* (e.g. Newell and Bumpus 2012) than in the SEA journals selected as the scope for this review. Chapters 5, 6 and 8 make a contribution to this, in different ways. Section 5.2.3 of chapter 5 provides a historical account of the early development of voluntary carbon offsetting (which preceded the creation of more formally regulated carbon markets by over a decade – see MacKenzie [2009, pp.442–3] for a brief account of the emergence of regulated carbon markets). Section 6.2.3 of chapter 6 then situates the critical enabling role that carbon accounting plays in carbon markets in relation to other forms of carbon accounting, and chapter 8 discusses a specific controversy in carbon accounting, where conflict between different views of the role of carbon sequestered in UK forests undermines the possibility of an effective market for UK forest carbon offsets.

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 et al. 2001; Sedjo & Marland 2003; Reijnders & Huijbregts 2003; Locatelli & Pedroni 2004; Bringezu et al. 2009; Ponsioen & 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.[15] Mathews' (1997, p.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." Again, chapters 5, 6 and 8 make a contribution to bridging these gaps between disciplines and between academic research and practice, by tackling some of the detailed scientific measurement issues to do with biogenic carbon accounting, within their social and political contexts. Controversies in accounting for forest carbon are inevitably the product of these intertwined scientific, social and political considerations.

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 relevant accounting entity (Lehman 1999). Despite Gray's (2002, p.692) observation that social accounting had "shaken off" the "shackles" of conventional accounting in favour of re-presenting 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, many of which have nothing to do with the corporation, and to imagine new alternatives. 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.

4.5. Summary

In conclusion, this review of the SEA literature on carbon accounting shows evidence of rapidly increasing academic interest in the subject, bearing out the prediction by Gray et al. (2007, p.17) of "an upsurge in interest in carbon accounting and, somewhat belatedly, an academic literature on it". Nevertheless, it also demonstrates that the focus of research to date is still relatively narrow – mainly preoccupied with empirical studies of carbon management accounting and corporate carbon disclosure – and that there is considerable scope for further research, particularly on how carbon accounting either enables or inhibits

[15] See https://www.cdproject.net/en-US/Programmes/Pages/forests.aspx (accessed 1 April 2013).

the effective functioning of carbon markets, as well as more interdisciplinary research and research grounded in practice. The remainder of this thesis includes two of the 13 papers classified as *about* carbon accounting (chapters 6 and 7) and two unpublished chapters (chapter 5 exploring the meanings of carbon accounting within its historical context as a practice and chapter 8 on the difficulties of accounting for UK forest carbon in carbon markets) which would also sit within this category of the emerging literature.

5. Carbon accounting in practice

An earlier version of the 'expanded' definition of carbon accounting provided at the end of this chapter was published in Ascui & Lovell (2011) and reproduced in Ascui & Lovell (2012), with some further discussion. In both cases these parts of the two papers were originally drafted by myself. Space constraints in both papers meant that the full background to the expanded definition could not be published; the bulk of this chapter provides this background analysis and has not previously been published.

5.1. Introduction

This chapter sets out to answer a very basic question: What is carbon accounting, in practice? In a well-established field, one could simply appeal to a dictionary or some other widely accepted definition in order to define one's terms. In slightly more ambiguous situations, a review and discussion of multiple sources from the academic literature might suffice. However, in the case of carbon accounting, because practice has leaped ahead of academic research, a review of the academic literature would not necessarily give us an accurate picture of what carbon accounting really is in practice. This was particularly the case when I first started this research in 2008 – as I demonstrate in chapter 4, virtually all of the academic literature on carbon accounting, at least within the field of social and environmental accounting, has been published since then. Therefore the current chapter focuses on the 'grey' literature (although it does also discuss contributions from a variety of academic sources) and is critically informed by my personal experience and participant observation of carbon accounting. This plays an essential role, because as I will demonstrate, 'carbon accounting' means many different things, to many different people. They do not all use the same terminology, and thus any approach to researching the topic that is not informed by some prior understanding of the diversity of carbon accounting in practice would most likely miss significant portions of the scope that I have included here. Even a large survey or 'snowballing' approach to expert interviews would not necessarily capture this diversity, as distinct communities are involved, and one would first have to understand this, and to learn who is involved and the different terminologies they use, before such methods could be effective.

The systematic literature review of carbon accounting carried out by Stechemesser & Guenther (2012), whilst illuminating in many respects, also demonstrates the limitations of a more deductive approach. This review was based on keyword searches of major

bibliographic databases (Science Direct, Emerald, Springer, Wiley, Business Source Complete and Web of Science), plus Google Scholar and a number of website of accounting companies (presumably the 'Big Four') and 'other' organisations (not specified). The search terms used were the following:

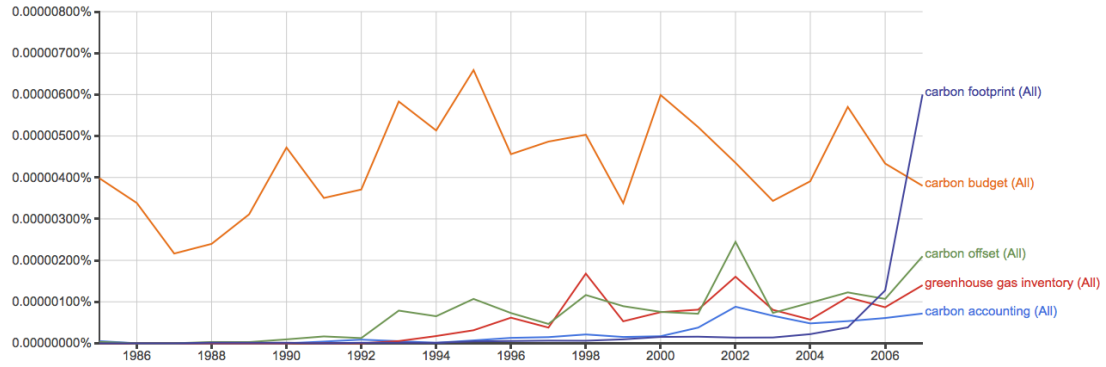
- "carbon * accounting"
- "CO2 * accounting"
- "greenhouse gas * accounting"
- "GHG * accounting"
- "climat* change * accounting".

The use of asterisks enables related terms such as "climate change accounting" and "carbon dioxide accounting" to be captured. However, an immediate problem is that many practitioners of carbon accounting are not accountants (in fact, as shown in chapter 4 in relation to research and in chapter 7 in relation to practice, accountants are relative newcomers to carbon accounting) and may not consider what they do to be 'accounting' at all. Terms such as "carbon footprint", "greenhouse gas inventory", "carbon budget" and "carbon offset" all relate to carbon accounting, but would not be picked up by the above keyword searches. The first version of this paper (Guenther & Stechemesser 2011) captured a relatively narrow scope, for example overlooking the vitally important area of carbon accounting in carbon markets. I pointed this out to the authors at a conference in 2011, and the final paper is more inclusive (also, by that time, including my own broad definition of carbon accounting from Ascui & Lovell [2011]). Nevertheless, this illustrates the difficulty of understanding what carbon accounting is by relying on literature searches alone – although, as time goes by, a more comprehensive picture of carbon accounting is now being built up in the rapidly growing academic literature (see chapter 4, the papers discussed in section 4.3.1 in particular).

Another disadvantage of relying on academic sources is that it misses out earlier working papers and practitioner-generated material, which in turn limits the historical scope of such a review. The earliest text cited by Stechemesser & Guenther (2012) is Perman (1994). This paper on 'The economics of the greenhouse effect' does not use the precise term "carbon accounting", but notes that "Accounting for GHG emissions by economic sector may be done through energy augmented input-output (I-O) modelling." (Perman 1994, p.101).

However, as I will discuss further below, use of the precise term "carbon accounting" can be traced back at least as far as 1991, in the grey literature (Trexler 1991). Figure 6 below provides supporting evidence for this from Google's database of 5.2 million digitised books and other texts published up to 2008, showing that the term "carbon accounting" starts to take off from 1991.[16] It also shows that "carbon budget" has a much longer history (going back to 1965, not shown here). "Carbon offset" starts to appear from 1988, whereas "greenhouse gas inventory" first appears only in 1993. The most interesting trajectory is that of "carbon footprint", which first appears in 1992 but remains the least used term until 2005, when it suddenly surges in popularity, becoming the most widely used of these terms within the space of just two years. In fact, I had to exclude 2008 data from the chart in order for it to be readable, because "carbon footprint" increases by 233% in that year, whereas the other terms remain roughly in the same territory (most on a linear trajectory). Other terms such as "CO2 accounting", "greenhouse gas accounting" or "GHG accounting" yielded negligible results. Clearly, therefore, a more complete picture of carbon accounting in practice must consider at least the key terms shown in Figure 6, and account for their relative trajectories.

Figure 6: Google Ngram of key terms, 1985-2007



Source: https://books.google.com/ngrams (accessed 12 December 2013).

The remainder of this chapter is organised as follows. Section 5.2 provides an account of the origins of different early versions or understandings of carbon accounting. It is organised roughly chronologically and also thematically according to the key terms shown in Figure 6 above. Then in section 5.3 I bring together these disparate understandings of carbon accounting in a proposed definition. Unlike most definitions which seek to reduce diversity

[16] Technically, this is the combination of terms "carbon" AND "accounting" rather than the single term "carbon accounting". The same applies to all other combined terms in Google Ngrams. For simplicity in this paragraph I have not spelled this out in each case.

to a simpler set of core, essential properties, however, my goal with this 'expanded' definition is to highlight the diversity, whilst identifying some common structural elements, in order to enable different forms of carbon accounting to relate to each other and to break down some of the conceptual barriers that prevent understanding across frames. The chapter concludes with a brief summary in section 5.4.

Finally, I acknowledge my subjective involvement in the subject of this chapter: not only because of my prior and on-going involvement in the practice of carbon accounting, but because in trying to define something that was previously amorphous and undefined, or at least understood very differently by different people, I am actively contributing to its social construction, in a particular way which has its own implications. My definition, as published in Ascui & Lovell (2011) and reproduced in Ascui & Lovell (2012), is now part of the academic discourse. By calling all of these different 'things' carbon accounting, I am implicitly prioritising the accounting discipline as a suitable location for its analysis, perhaps at the expense of other disciplines, some of which (as I will show) have a much longer association with the subject. I am therefore complicit (with others) in a kind of academic colonisation of the subject. I would not like to see this colonisation taken too far, however, as I believe the subject has far more to benefit from interdisciplinary collaboration than competition.

5.2. A brief history of the practices of carbon accounting

5.2.1. The global carbon cycle and carbon budgets

Historically, carbon accounting undoubtedly starts with scientists measuring, calculating or estimating the stocks and flows (fluxes) of carbon in the global carbon cycle. The first quantitative account of how carbon cycles between the atmosphere (mainly as carbon dioxide), the oceans (as dissolved carbon dioxide or carbonic acid), and rocks (in the form of carbonates) was given by the Swedish geologist Högbom in 1894. Even before that, various nineteenth-century scientists had been measuring the amount of carbon dioxide in the atmosphere (Fraser et al. 1986). Högbom's account, which included an estimate of the human-induced contribution from combustion of fossil fuels, was later used by his chemist colleague Arrhenius to postulate the theory that the latter activity could cause long-term warming of the global climate, in a seminal 1896 paper (Högbom 1894; Arrhenius 1896; Rodhe et al. 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; IPCC 2013). 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.

In more recent times, the definitive scientific experiment to directly observe carbon dioxide concentrations in the atmosphere was set up by Keeling on the flanks of Mauna Loa (this remote and high-altitude location chosen in order to obtain a reasonably globally representative air sample) in 1957 (Pales & Keeling 1965). The experiment continues to the present day, resulting in the data series shown in Figure 1 (see chapter 1). Versions of the same experiment, using flux towers, can provide direct measurements of gas concentrations, and thus infer emissions from changes in concentrations, at the local level (Bergameschi 2007; Ciais et al. 2010), or regionally with a flux tower network. A variety of other instruments including weather balloons and research aircraft also provide direct measurements, and can now (since 2009) be combined with global satellite monitoring.[17]

Modern scientific understanding of the carbon cycle requires the combination of vast quantities of data from many different kinds of measurements with complex calculations and modelling. Modelling can be involved even in what I have called direct measurements above – for example, measurements from flux towers (at a fixed height) are converted into calculations of vertical fluxes within the atmosphere using complex 'eddy covariance' models (Baldocchi 2003). The use of complex numerical models of the Earth's climate system, known as General Circulation Models or global climate models, is now an important part of the way in which scientists construct their accounts of how greenhouse gases circulate and affect the climate.

From 1965 onwards, faced with Keeling's evidence of steadily increasing carbon dioxide concentrations in the atmosphere, combined with growing awareness of the potential implications of this in terms of climate change, it became increasingly important for scientists to understand all parts of the global carbon cycle, as well as equivalent global cycles for other greenhouse gases, in detail. "Since the initial discovery [in 1965] of the

[17] See http://www.jaxa.jp/press/2012/12/20121205_ibuki_e.html (accessed 9 December 2013).

increase in CO_2, the other greenhouse gases have been identified, quantified and modelled… Scientists within the geosciences have increasingly adapted a global view…" (Rodhe et al. 1997, p.4).

As the Earth is a closed system, all carbon flows must be theoretically accountable as a balance between emissions to the atmosphere and the sum of withdrawals and accumulation in the atmosphere, graphically represented in Figure 7 below. The idea that flows of carbon within the biosphere must be in balance lends itself to the idea of a carbon 'budget' or "CO_2 budget accounting" (Sundquist 1993, p.940). In fact, Sundquist (1993, p.934) argues that:

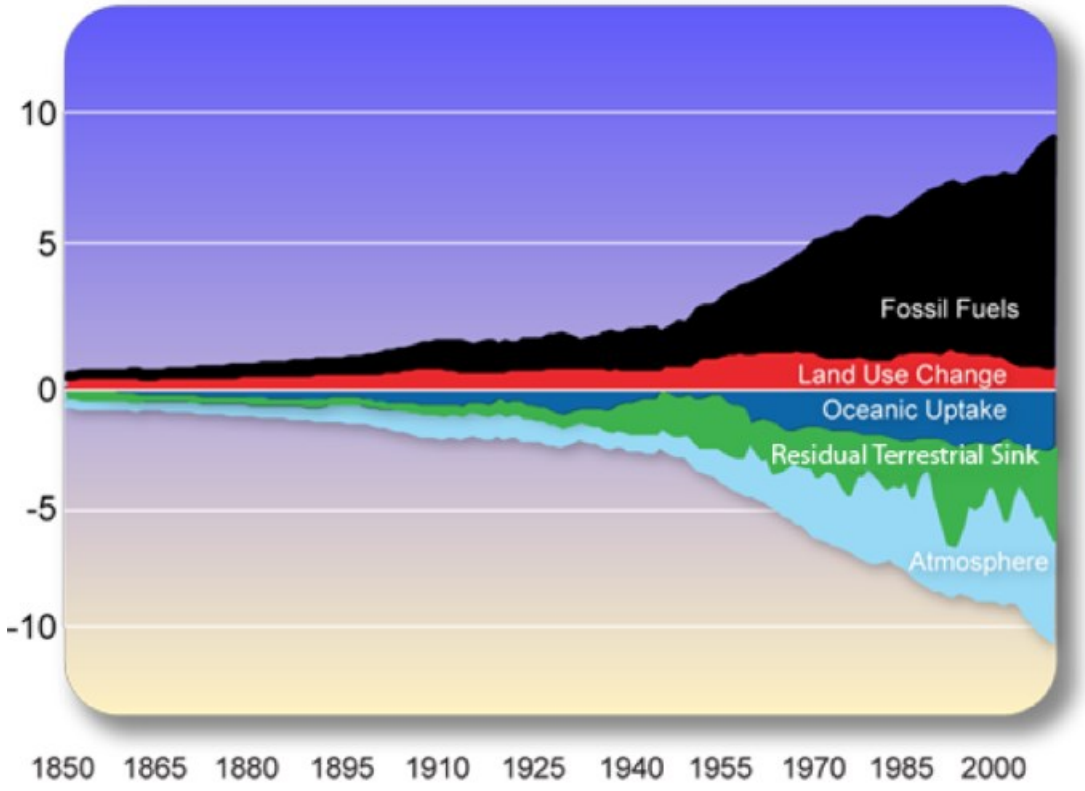
> "Biogeochemists are the budget experts of the earth sciences. They monitor the income and outgo of materials through intricate biological and geochemical transactions. Budgets of many elements – especially C, N, P, and S – are necessary to understand the factors that contribute to environmental problems such as acid rain, eutrophication, and the greenhouse effect. No biogeochemical problem has drawn more recent attention than the global budget of atmospheric CO_2."

Although Pales & Keeling did not use the term 'carbon budget' in their landmark 1965 paper, it is unlikely to be pure coincidence that the trajectory of the term in Google's database of digitised publications starts to increase steadily from this point forward.

The parts of the global carbon budget that have presented the greatest challenge to scientific measurement have been those to do with the oceans, and forestry and land use (now generally discussed under the acronym LULUCF, short for land use, land use change, and forestry). LULUCF is particularly challenging because its contribution is large, uncertain, and highly dependent on human activities. Oceanic up-take of carbon dioxide is also large and uncertain, but not generally dependent on human activities, except through the agency of climate change itself (Ballantyne et al. 2012). Emissions from fossil fuel combustion and cement production could be calculated relatively easily, from collated national statistics, but by the late 1980s, the best estimates of the magnitude of additional emissions from tropical deforestation and land use change ranged from 8% to 47% of fossil fuel and cement emissions (Brown et al. 1989, p.882). In addition, unlike sectors such as fossil fuel combustion and cement production, which can only range in value from zero to some positive extreme, lands devoted to forestry and agriculture may either draw down, store or release carbon, depending on how they are managed; their carbon accounting therefore has both positive and negative dimensions of uncertainty.

At the global level, a key preoccupation for climate scientists from the 1980s onwards has been how to account for the so-called 'missing sink' – a substantial amount of carbon (in the order of a billion tonnes) that is assumed to be absorbed every year. This is not measured, but inferred from the difference between relatively well-understood emissions, accumulation in the atmosphere, and the other main process of carbon storage, absorption into the oceans, as shown in Figure 7 below. The precise location and processes that make up the 'missing sink' are still debated, but there is now general agreement that it is located in the terrestrial biosphere, either in tropical or northern mid- to high-latitude forests (Erb et al. 2013). The fact that this is still uncertain, more than 30 years after the issue was first identified, highlights the immense technical challenges in accounting for forest carbon.

Figure 7: The global carbon balance showing the 'missing' or residual carbon sink (GtC)



Source: Woods Hole Research Center, http://www.whrc.org/global/carbon/residual.html (accessed 12 December 2013).

Thus, while the term 'carbon budget' is widely used by scientists studying the carbon cycle in general, it is also used (from at least the 1980s) by forest scientists in particular. For example, Delcourt & Harris (1980) describe as a 'carbon budget' their analysis of changes in stored biotic carbon in the south-eastern United States from 1750 to 1980 (one of the first studies to attempt to account for biotic carbon over a long time period at a regional level –

Trexler 1991, p.70). They present their results in a table, recognisable as a form of carbon account, showing the carbon stored in different types of land use (virgin forest, secondary forest and non-forest land) at different points in time (years), with the annual change in total carbon as a flux which is either positive or negative depending on whether carbon is being stored or released overall (the results overall show a massive release of 42 billion tonnes of carbon to the atmosphere from clearing of virgin forests since 1750, which is only partially offset by around 15 billion tonnes of carbon stored in secondary forests and non-forest land use).

5.2.2. Carbon accounting and national greenhouse gas inventories

Apart from 'carbon budget', all of the other key terms for carbon accounting emerge from 1988 onwards. This was a period in which climate change was undergoing a significant shift from an issue of purely scientific to wider social and political interest. This sub-section describes the growing international and national politicisation of carbon accounting at this time, while the next sub-section discusses the role of pioneering non-state actors, including both corporations and NGOs.

Several key events stand out in the years immediately before this transition. One was the dramatic scientific discovery of the Antarctic ozone 'hole' in 1985 (Farman et al. 1985; WMO 1985), which led extremely rapidly to the 1985 Vienna Convention for the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. Another key event was the publication in 1987 of the Brundtland Commission report, *Our Common Future* (World Commission on Environment and Development 1997), widely credited with defining and setting the agenda for sustainable development. The rapid translation of ozone science into international policy has been characterised by Haas (1992a) as being strongly influenced by an ecological epistemic community of specialists who shared a common framing of the issue. Many individuals from this community of ozone specialists went on to become key players in the translation of climate change science into policy, and carried the experience of this science-politics interface with them. For example, Bob Watson, who as Director of the Science Division at NASA coordinated the WMO (1985) ozone report and played a key role as 'knowledge broker' in the development of the Montreal Protocol (Litfin 1995, p.256), went on to become Chair of the Intergovernmental Panel on Climate Change (IPCC) from 1997 to 2002.

With respect to climate change in particular, "1988 was the year that broke the mould", according to petroleum geologist turned climate campaigner Jeremy Leggett: "The news about global warming that summer became impossible to ignore" (1999, pp.viii–ix) – in part due to coincidental external factors such as the worst drought in the US since the 'Dust Bowl' years of the 1930s (Litfin 1995, p.276).[18] Also in 1988, "46 countries… sent representatives to a conference in Toronto which proposed the adoption by the world community of the goal of cutting carbon dioxide emissions from human activity to 20 per cent below their then current level by 2005" (Common & Salma 1992, p.32). In the same year, the UN set up the IPCC, which in May 1990 issued its First Assessment Report, advising that a programme should be established "for the development and implementation of global, comprehensive and phased action for the resolution of the global warming problem under a flexible and progressive approach." (IPCC 1990, p.56). At the Second World Climate Conference in November 1990, a 'Scientists' Declaration' concluded: "Countries are urged to take immediate actions to control the risks of climate change." (Leggett 1999, p.21). Accordingly, in December 1990, the UN General Assembly decided "to establish a single intergovernmental negotiating process under the auspices of the General Assembly, supported by the United Nations Environment Programme and the World Meteorological Organization, for the preparation by an Intergovernmental Negotiating Committee of an effective framework convention on climate change…".[19] From February 1991 to June 1992, intense international negotiations were underway, involving combinations of scientists and policy-makers, culminating in the adoption of the UN Framework Convention on Climate Change (UNFCCC) at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, the so-called 'Earth Summit' (Leggett 1999; Lövbrand & Stripple 2006).

A political agreement for the "resolution of the global warming problem" would inevitably transform carbon accounting from a matter of pure research into a matter of responsibility and action, with nation-states in the spotlight. During this period, therefore, it was suddenly becoming important to understand the spatial distribution of greenhouse gas emissions and removals at a different scale: from global to national. Lövbrand & Stripple examine this political transformation or 'territorialisation' of the global carbon cycle, explicitly acknowledging the enabling role played by calculative practices:

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[18] See also http://www.weather.com/encyclopedia/heat/heat.html (accessed 13 December 2013).
[19] 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).

> "The history of modern territoriality is closely linked to the development of bureaucratic power and particularly states' ability to *measure, survey and visualise*. It is easy to realise that the flows of carbon through the Earth system do not easily lend themselves to the spatiality of the state system. However, with the support of modern technologies for *controlling, modelling and measuring* atmosphere-biosphere interactions, the carbon cycle has during the past decades been moulded onto territorial ground. …the domestication of the global carbon cycle is intimately linked to discourses of management and commodification." (2006, p.216; my italics).

Forests played a particularly important, if equivocal, role in this process of national territorialisation and accountability, because of their ability to represent both a source and 'sink' of emissions, and the large uncertainty around both positive and negative accounting values. This created an opportunity for some industrialised countries, which had generally deforested earlier in their history and hence now experienced a carbon 'sink' in re-growing forests, to argue that this should reduce their responsibility for their emissions from industrial activity:

> "Leaning on scientific studies of the 'Northern sink', industrialised countries with large forest areas such as the USA, Canada, Russia, Sweden and Finland introduced the idea of 'net emissions' to the pre-UNCED negotiations. According to this accounting logic countries should be allowed to subtract the amount of carbon stored in ecosystems within state borders from national greenhouse gas emissions in a future climate accord." (Lövbrand & Stripple 2006, p.226).

As a result, the concept of net accounting became enshrined in the UNFCCC through the terminology of "national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol" (United Nations 1992, Article 4.1 [a]). Thus 'greenhouse gas inventory' enters the lexicon, from 1993 according to Google (see Figure 6, p.109).

It is against this backdrop that the concept of a 'carbon budget' first starts to be expressed as 'carbon accounting'. The subtle discursive difference between the two terms parallels the wider political shift from viewing carbon flows as something given (like a budget or balance) to something humanly created, for which responsibility must be taken (an account). Carbon was becoming accountable, particularly by nation-states.

The earliest source that I have been able to identify using the specific term 'carbon accounting' (Trexler 1991) was published by the World Resources Institute, an NGO that

has been particularly influential in many forms of carbon accounting (see subsequent sub-sections of this chapter). This report advocates calculation of the effects of forest and agricultural policy on the carbon balance in the United States in order to understand whether a policy may aggravate or slow global warming:

> "Fully and reliably accounting for all of these variables, of course, is impossible, since some of them reflect an inevitable uncertainty about the future. Careful "carbon accounting" should, however, provide as accurate as possible an assessment of first-order carbon balances. … In addition, as many second-and third-order effects as possible should be incorporated into the analysis, particularly for projects large enough to affect timber and agricultural commodity prices. Even without firm projections, such an analysis should reveal how reliable the projections of primary benefits and cost-effectiveness are." (Trexler 1991, p.51).

Another early document (Common & Salma 1992) does not use the specific term 'carbon accounting', but is titled 'Accounting for Australian carbon dioxide emissions' and uses the term "accounting" 17 times, in statements such as: "This paper provides an accounting for carbon dioxide emissions arising in Australia by final demand deliveries responsible, using input-output and primary energy input data for 1982-83." It was originally published in 1990 as a working paper (cited in Perman [1994]). Common & Salma (1992, p.37) in turn cite a 1989 working paper version of Gay & Proops (1993) as the "only… other study accounting for carbon dioxide emissions in terms of final demand deliveries." Whilst again the latter paper does not use the specific term 'carbon accounting', it provides a similar national account based on input-output analysis, in this case for the UK.

While the methodologies, coverage and time-frame of the accounts given by Trexler (1991) and the latter two studies differ, they share a common interest in providing as comprehensive a picture as practicable of national-level responsibility for human-induced climate change, *in order to facilitate better management of the problem by policy-makers*. In the next sub-section, I will discuss the different approach to carbon accounting taken by certain pioneering corporations and NGOs, also aimed at better management of the problem, but this time by non-state actors.

Figure 6 shows relatively low use of the term 'carbon accounting' from 1991 to 2000, then an increase from 2001 onwards. My own experience, and feedback from key informants, suggests that most of the trajectory shown for this term relates to forest carbon, and that the

term only becomes used in a broader sense from 2008 onwards (unfortunately not shown in Figure 6, as Google's database is only available up to 2008).

The increase from 2001 can be related to the fact that LULUCF 'sinks' were again a flashpoint of contention in the negotiations leading up to the 1997 Kyoto Protocol, because of their potential to reduce the pressure on making real reductions in fossil fuel emissions, seen by many as the main goal of the treaty (Fogel 2005). To help policy-makers deal with the many complex technical issues raised by this sector, the IPCC was requested to prepare a special report, published as the *Special Report: Land Use, Land Use Change, and Forestry* (IPCC 2000). This was described by one negotiator as "probably the most immediately policy-relevant and therefore potentially the most sensitive" IPCC report ever, due to the political ramifications of treating land-use based removals as equivalent to fossil fuel emission reductions (Fogel 2005, p.193). By this time, the term 'carbon accounting' was evidently sufficiently familiar in the context of LULUCF to be used ubiquitously in the Special Report, without specific definition, although reference is made, *inter alia*, to "Rules for accounting for carbon stock changes and for emissions and removals of greenhouse gases from LULUCF activities…" (IPCC 2000, p.3).

The IPCC Special Report served to clarify and make transparent – albeit in a highly technical publication more likely to be accessed by experts than the general public – the very significant impacts of seemingly 'technical' accounting choices in the LULUCF sector:

> "Probably the most relevant quantitative information provided by the report related to the options available to Parties for defining and accounting for the activities of afforestation, reforestation and deforestation. In 130 pages on this question, IPCC authors clarified the surprisingly large quantitative implications that decisions on these seemingly 'technical' definitional issues would have. Depending on the combinations used, industrialized countries could be faced with debits of about 849 megatons of carbon per year or credits of 483 megatons [of] carbon per year… These figures clearly implied the possibility for industrialized countries to meet their entire emission reduction targets for the first commitment period from afforestation and reforestation activities alone." (Fogel 2005, p.204).

These uncertainties were eventually dealt with through a system of caps on the amount of 'credit' that developed countries could take for afforestation, reforestation and other activities, agreed in 2001 (Fogel 2005; Lövbrand & Stripple 2006). However, national accounting for LULUCF remains highly problematic, as I discuss further in chapter 8.

Since 2008, the term 'carbon accounting' has entered the social and environmental accounting academic literature (chapter 4) and also popular culture. For example, an article in *The Economist* on the launch of the first greenhouse gas monitoring satellites in 2009, titled 'Greenhouse gases: Accounting from above', even called the satellites "carbon accountants":

> "These new satellites will work as carbon accountants, by keeping a close eye on how the Earth breathes and returning regular audits… And some researchers… think that satellites could also monitor the effect of policies, such as carbon trading, that are adopted to rein in emissions. The new birds in the sky really would then become carbon accountants." (The Economist 2009).

It is unlikely, however, that even if Figure 6 could be extended to the present, the use of 'carbon accounting' would have exceeded the popularity of the terms considered in the next two sections, 'carbon offset' and 'carbon footprint'.

5.2.3. The origins of carbon offsets

The fact that forests can act as a 'sink', drawing carbon dioxide out of the atmosphere and storing it in biomass, thus conceptually acting as emissions in the negative or cancelling out emissions, perhaps helps to explain why forestry activities were the first to be commodified as carbon 'offsets' at the project level.[20] The idea of planting forests to offset human-induced emissions of carbon dioxide can be traced back at least as far as 1977 (Dyson 1977; Moura Costa & Stuart 1998). However, the concept of carbon offsetting had never before been realised in practice until 1988, when the US energy company AES (Applied Energy Services) decided to voluntarily offset the 15 MtC estimated to be emitted over the 40-year lifetime of its new 180 MW coal-fired plant in Connecticut, USA (Dixon et al. 1993, p.567).

AES was an independent, entrepreneurial energy company with a strong sense of environmental and social responsibility. Its co-founder and CEO Roger Sant had previously been Assistant Administrator for Energy Conservation and the Environment at the Federal Energy Administration and Director of an energy efficiency research centre affiliated with Carnegie Mellon University, and the idea behind the company was to provide energy services, including efficiency in both production and consumption of energy, rather than

[20] Other reasons included perceived low cost, high potential rates of carbon sequestration, and ancillary social and environmental benefits, such as biodiversity or watershed protection and improved livelihoods (Moura-Costa & Stuart 1998).

straightforward energy supply. The company's 1991 initial public offering prospectus had made clear to investors the company's "commitment to four major "shared" values: to act with integrity, to be fair, to have fun and to be socially responsible. …if the Company perceives a conflict between these values and profits, the Company will try to adhere to its values… Moreover, the Company seeks to adhere to these values not as a means to achieve economic success, but because adherence is a worthwhile goal in and of itself." (Grose 2007, p.50). The decision to offset emissions from a new plant voluntarily was led by the CEO in a deliberate effort to "confront the looming problem of global warming" (Grose 2007, p.63).

AES contracted the World Resources Institute[21] (WRI), described as "an environmental policy think tank and lobbying group" (Moura Costa & Stuart 1998) and where AES CEO Sant was on the Board of Directors (Grose 2007, p.63) to conduct a global search for suitable carbon offset opportunities. As we shall see later, the WRI has been a key player in multiple forms of carbon accounting, as the developer of the GHG Protocol standard for corporate carbon accounting (WBCSD & WRI 2001; WBCSD & WRI 2004), an early standard for project-based carbon accounting (WBCSD & WRI 2005) including specific guidance on LULUCF carbon accounting (WRI 2006), and standards for supply chain carbon accounting and product level carbon accounting (WBCSD & WRI 2011a; WBCSD & WRI 2011b), as well as being a founding member of the Climate Disclosure Standards Board (CSDB) (see section 7.4). The call for proposals did not exclude projects that would have reduced emissions in the energy sector, but "there was substantially greater emphasis placed on forestry options, due to the perception that forestry could be a substantially more cost-effective mechanism." (Moura Costa & Stuart 1998).

After receiving nearly 100 proposals, in 1989 AES decided to invest US$2 million in an endowment fund, with the interest supporting an existing agroforestry and woodlot plantation project in Guatemala (Dixon et al. 1993; Moura Costa & Stuart 1998). "To create accountability, they [AES] asked WRI to calculate how many trees would be needed to absorb the carbon emitted over the plant's expected forty-year life span. Using only the crudest hypothetical model and with no field experience to back them up, the WRI analysts

[21] Technically, AES approached the American office of the International Institute for Environment and Development (IIED), which became part of the WRI in 1988 (Trexler et al. 1989). IIED is an environmental (and development) policy research institute or think-tank which was established in the early 1970s, headquartered in London with another office in Edinburgh. Two areas related to carbon accounting to which IIED has made significant contributions include payments for ecosystem services (PES) and Reducing Emissions from Deforestation and Degradation (REDD) (Engel et al. 2008; Bond et al. 2009).

suggested that 52 million trees would do the trick." (Grose 2007, p.65). More specifically, it was calculated that this project would offset 15.5-16.4 MtC over the 40-year lifetime of the AES plant, in other words more than the plant was projected to emit (Wittman & Caron 2009, p.713).

The apparent simplicity of the previous sentence belies the amount of innovative calculative 'work' that had to be undertaken in order to make such a statement. Prior to 1989, "no prior estimates of this sort had ever been made at the project level. Previous estimates were of a global nature and of limited use for the exercise." (Faeth et al. 1994, p.21). Having to choose, in an impartial and non-arbitrary manner, between nearly 100 different proposals highlighted "the difficulty of estimating carbon sequestration and the near impossibility of making fair comparisons among proposals when many different methods and assumptions were used." (Faeth et al. 1994, p.9). The original estimate of the sequestration potential of the AES Guatemala project (Trexler et al. 1989) was highly simplified and static, with all parameters assumed to remain constant over the project's 40-year lifetime (Faeth et al. 1994, p.21). For example, the carbon sequestered from woodlots and agroforestry was calculated as follows:

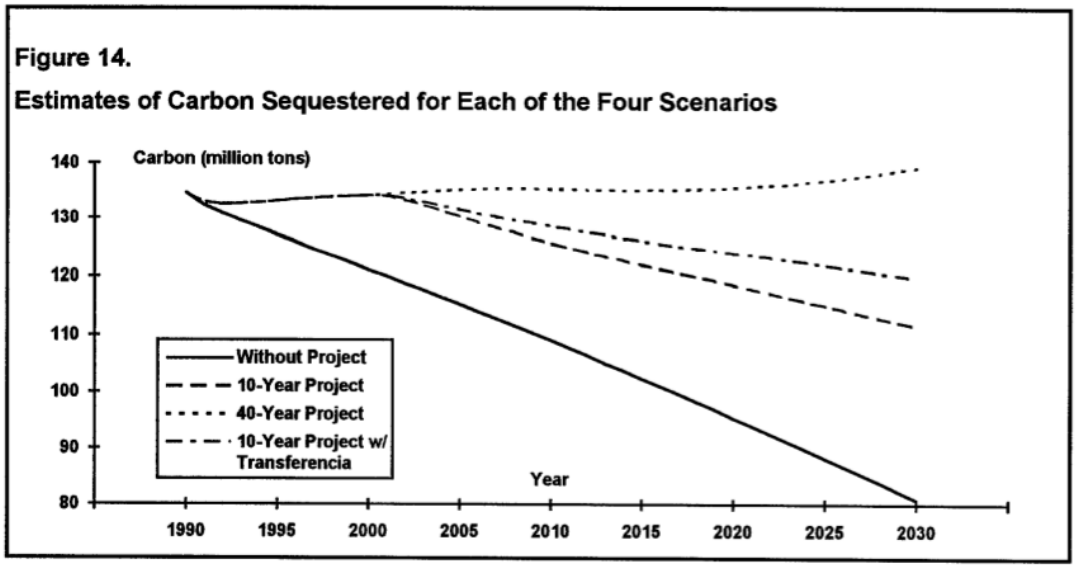
> "(Annual area planted * planting period * total biomass growth * carbon content) * ([1 - % biomass harvested/100] + [usable branch wood multiplier * % biomass harvested/100 * demand displacement multiplier])" (Faeth et al. 1994, p.25).

A re-examination of the input assumptions in 1994, using the same static model, resulted in a downward revision of the estimated carbon sequestration from 16.4 to 10.5 MtC (Faeth et al. 1994, p.24). Frustration with the static nature of this assessment led WRI to develop a dynamic Land Use and Carbon Sequestration (LUCS) model, described as "an accounting tool" (Faeth et al. 1994, p.9) to evaluate the implications of different scenarios, including second-order as well as first-order effects. The LUCS model estimated carbon sequestration from the AES Guatemala project at 30-58 MtC for different scenarios, with second-order effects being considerably larger than the first-order impacts (Faeth et al. 1994, p.31).[22]

[22] An example of a first-order impact might be the carbon sequestered in planted woodlots (on average over the harvesting cycle), while a second-order impact might be the carbon retained as a result of reduced harvesting of existing forest, due to being able to meet demand for fuelwood from the planted woodlots.

It is important to note that something qualitatively very different is going on here, compared with scientific assessments of carbon budgets or even national inventories of emissions and removals. The former are generally backward-looking and intended to represent actual, absolute amounts of carbon emitted to or removed from the atmosphere, within variously defined boundaries. However, as Figure 8 illustrates, what is now being estimated is not the *absolute* amount of carbon sequestered as a flow from the atmosphere into biomass, but the *difference* in stocks between a project scenario and a 'without project' baseline. As Faeth et al. (1994, p.31) put it, "Even though there may an absolute loss of carbon for a given scenario, there could be less carbon lost than for the baseline, and therefore an absolute gain for the atmosphere [*compared to what would have happened otherwise*]." The text in italics is the often unspoken, yet absolutely critical assumption that underlies this form of carbon offset or emission reduction accounting.

Figure 8: WRI LUCS model estimates of carbon sequestered by the AES Guatemala project



Source: Faeth et al. (1994, p.32).

These early assessments of the AES Guatemala project were forward-looking or ex-ante, thus both the 'project scenario' and 'without-project baseline' were hypothetical, modelled estimates. However, even with a backward-looking or ex-post assessment of an emission reduction project, at least one half of the equation (the baseline, or what would have happened anyway) is by definition hypothetical and cannot be directly measured. This makes any such carbon offset accounting inherently contestable. The fact that offsets are used to justify emissions elsewhere also makes them inherently political.

An independent evaluation of the project's first decade was conducted in 1999 by Winrock International, another US-based NGO which has been very influential in carbon accounting, particularly in relation to LULUCF, and which founded the American Carbon Registry in 1996, a voluntary carbon offsetting standard which is now approved as an offset registry for the California cap-and-trade scheme.[23] This report found that only 0.27 MtC had been sequestered over the project's first ten years (Brown & Delaney 1999; cited in Wittman & Caron 2009, p.714).[24] The discrepancy highlights both the technical challenges of accounting for carbon sequestered in forestry activities, and the highly political nature of such apparently 'technical' considerations. For example, Wittman & Caron (2009, p.715) argue that "due to the project's required emphasis on carbon sequestration, scarce resources and personnel were redirected from poverty alleviation extension and service work to efforts required for carbon offset accounting." The Winrock evaluation had recommended:

> "developing a land-use mapping system using geographical information systems (GIS) and remote-sensing technologies… They also suggested identifying valid zones to act as proxy areas to serve as a ''without-project'' baseline, and finally called for the design and implementation of a carbon monitoring program for all project activities for which carbon offset credits will be claimed." (Wittman & Caron 2009, p.715).

These recommendations were made in order to be able to make more robust estimates of the carbon sequestered by the project. From one perspective, they reflect what is now generally well established practice for such carbon accounting under the Kyoto Protocol Clean Development Mechanism (CDM) and other carbon offsetting standards (Olander & Ebeling 2011). However, from other perspectives this can look like 'carbon colonialism' (Smith 2007). The technical complexity of carbon offset accounting makes it all too easy for different actors to talk past each other. A comment made by the person who developed the LUCS model at WRI, in response to an online article reporting the criticisms of Wittman & Caron (2009), exemplifies this:

> "I was one of the people at WRI who evaluated and recommended the CARE/Guatemala project to AES. There are a number of errors in the above article. …the authors fail to point out the reasons for the differences in the offset estimates, *which were due to the methodologies used*. …Several years

[23] See http://www.winrock.org/ and http://americancarbonregistry.org/ (accessed 11 December 2013).
[24] I do not have access to the original report (Brown & Delaney 1999) and therefore cannot be sure if the 270,000 tonnes of carbon cited in Wittman & Caron (2009, p.714) is expressed in tC or tCO_2, but the former seems more likely as the latter would be even smaller than the original estimate. I also cannot be certain whether the figure has been misrepresented in any way.

> after the project was approved by AES, we went back and developed a very simple land use model to account for unsustainable forestry practices which the agroforestry methods were intended to replace. We also took a longer-term point of view to account for the maturation of the trees over the life of the power plant, not just the first 10-years. This research was done to help understand what might be going on [in] a project like this, *not to provide a definitive offset estimate*."[25] (my italics).

The AES Guatemala project was the first of many such carbon offset projects. AES also committed US$2 million to a Nature Conservancy project to protect an area of endangered tropical forest in Paraguay, estimated to save 13 MtC, to offset emissions from its Barbers Point 180MW coal-fired plant in Oahu, Hawaii (Dixon et al. 1993) and a further US$3 million to an Oxfam America project to help indigenous Amazonian peoples to gain legal title to and more effectively manage 1.2 million acres of land (Moura Costa & Stuart 1998), linked to a new 320MW plant in Oklahoma (Grose 2007). In 1990, the Dutch Electricity Board, representing five electricity companies in the Netherlands, set up the Forests Absorbing Carbon dioxide Emissions (FACE) Foundation, originally with the intention to plant forests in various parts of the world to offset emissions from a new coal-fired power plant in the Netherlands, with a budget of US$180 million (Moura Costa & Stuart 1998). These early projects have been criticised for not going through quality assurance processes which are now standard, such as third-party audit and listing in a third-party registry, leading to scepticism and suspicion from environmental activists (Moura Costa & Stuart 1998). However, these quality assurance procedures and institutions did not exist at the time. A two-stage approach to carbon offset auditing, involving a separation between validation and verification activities (generic concepts widely used across other fields, such as software, product or scientific model quality assurance – see for example Oreskes et al. [1994]), was co-developed over time by government, private and third sector actors.

Article 4.2 (a) of the UNFCCC allowed developed countries to implement climate change mitigation actions jointly, thus raising the prospect of some form of official recognition of offset projects. Moura Costa & Stuart (1998) describe how the UNFCCC approach to joint implementation raised further interest from investors, which was then quashed in 1995 at the First Conference of Parties (COP) to the UNFCCC, when "developing country dissatisfaction was voiced as a formal refusal of JI with crediting against objectives set by

[25] Response by Paul Faeth, dated 7 November 2009, to an article by Chris Lang, 'How a forestry offset project in Guatemala allowed emissions in the USA to increase', 9 October 2009, available at: http://www.redd-monitor.org/2009/10/09/how-a-forestry-offset-project-in-guatemala-allowed-emissions-in-the-usa-to-increase/ (accessed 11 December 2013).

the Convention… [which] substantially dulled the appetite for participation among private sector parties". Nevertheless, as a compromise, an official pilot phase was initiated, known as Activities Implemented Jointly (AIJ), with the objective "to establish protocols and experiences, but without allowing carbon crediting between developed and developing countries." (Moura Costa & Stuart 1998). Although this phase was less successful at involving the private sector, the engagement of nation-states in project-level carbon accounting from 1995-1996 led to the development of rules and procedures by national regulatory bodies. In 1996, Pedro Moura Costa, a Brazilian forest scientist who had been involved in one of the FACE Foundation's carbon offset projects in Malaysia since 1991, started working with the government of Costa Rica, which wanted to sell government-approved carbon credits to the government of Norway (Bayon 2005; Moura Costa & Stuart 1998). "'In order to make the most of their carbon – they wanted to make sure that whatever they sold was properly certified' recounts Moura-Costa, 'and that's when I came in'." (Bayon 2005). Moura Costa developed and in early 1997 licensed to the international certification company Société Générale de Surveillance (SGS) the first certification system for carbon offsets, comprising a published standard (which was drawn up from the project selection requirements of different AIJ regulatory bodies) and procedures for verifying compliance against the standard by a certification body (in this case, SGS).

Many components of the SGS carbon certification system then became part of the regulatory framework for project-level carbon crediting under the Kyoto Protocol Clean Development Mechanism (CDM), and many subsequent standards. Article 12.5 of the Kyoto Protocol states that "Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties…" (United Nations 1998). Under the SGS system, three different kinds of certificate could be awarded to projects (Moura Costa et al. 2000): a Certificate of Project Design, based on ex-ante assessment of a project against a set of eligibility criteria (the equivalent process today is known as *validation*), a Schedule of Projected Emission Reduction Units (which became a required part of the CDM project design documentation) and a certificate stating the amount of certified carbon offsets, based on ex-post evaluation of a project (which became known as *verification* and *certification*). The validation and verification framework developed for the CDM was adopted in ISO140064-3 *Specification with guidance for the validation and verification of greenhouse gas assertions* (ISO 2006c) and followed by most subsequent voluntary carbon offsetting standards, including the dominant Verified Carbon Standard (Verified Carbon Standard Association 2013). Thus an accountability framework originally

developed for forest carbon offsets became a generic framework for carbon offset accounting, and a fundamental enabler of carbon markets in general, because it created trust in what was otherwise an intangible and essentially imaginary commodity: quantified reductions in emissions (or increases in removals), compared to what would have happened otherwise. The irony is that due to specific accounting rules which were set in place for forest carbon offsets under the CDM, making them temporary rather than permanent, and therefore different to all other CDM credits (Neeff & Ascui 2009), forests ended up playing an insignificant role in the eventual CDM market, making up less than 0.5% of total credits issued under the CDM to December 2012.[26]

A full history of the development of carbon markets is beyond the scope of this thesis; for detailed snapshots of its development over time the reader is referred to the market overviews published by the World Bank (Kossoy et al. 2013; Kossoy & Guignon 2012; Linacre et al. 2011; Kossoy & Ambrosi 2010; Capoor & Ambrosi 2009; Capoor & Ambrosi 2008) and the similar reviews focussing on the voluntary carbon markets published by Ecosystem Marketplace and New Energy Finance (Peters-Stanley & Yin 2013; Peters-Stanley & Hamilton 2012; Peters-Stanley et al. 2011; Hamilton et al. 2010; Hamilton et al. 2009; Hamilton et al. 2008). In brief, the voluntary experiments with forest carbon offsetting initiated by AES in 1989 quickly broadened to include reductions in emissions of greenhouse gases other than carbon dioxide from many other sectors of the economy (such as energy generation and destruction of industrial gases), and new regulatory mechanisms such as the CDM (the initial operational rules for which were agreed at Marrakesh in 2001) overtook the earlier voluntary transactions. Forestry-related activities were excluded or limited within most of these new regulatory mechanisms, specifically for accounting-related reasons:

> "The primary reason for forest carbon being sidelined from regulatory markets was controversy around issues such as (1) permanence, or keeping the carbon in the trees over the term of the carbon agreement), (2) additionality, or whether the projects would have occurred without carbon investments, and (3) leakage or spill-over of carbon releasing activities on to other lands." (Waage & Hamilton 2011, p.1).

However, since 2006 LULUCF projects have enjoyed a resurgence in the voluntary carbon markets, despite on-going accounting-related challenges, particularly for forest carbon projects in the UK (see chapter 8 for further discussion).

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[26] Source: Data as of 1 January 2013 from UNEP Risoe CDM pipeline, http://www.cdmpipeline.org.

5.2.4. Corporate and product carbon footprints

The concept of carbon offsetting initiated by AES in 1989 depended on creating equivalence between two different measurements. The preceding discussion has focussed on the intricacies of accounting for emission reductions, or enhanced removals, against a baseline of what would have happened otherwise, on the 'offset' side of the equation. However, in order to make what AES CEO Sant called an "environmental quid pro quo" (Grose 2007, p.66) it was first necessary to measure the emissions side of the equation, at the AES plant. Like offset accounting, this turned out to be not as simple as it might first appear. It may be relatively straightforward for a single plant burning a single fossil fuel such as coal or gas: the IPCC methodologies for developing national greenhouse gas inventories (IPCC 1997c) specify how to convert 'activity data' such as the tonnes of coal used in the plant into estimated emissions of carbon dioxide, generalizable as follows:

$$E = AD \times EF \times OF$$

Where:
E = Emissions (in tCO_2);
AD = Activity data (e.g. tonnes of coal, converted to energy equivalent on a net calorific value basis[27], therefore expressed in a unit of energy, e.g. terajoules, TJ);
EF = An appropriate emission factor for that particular fuel, expressed in tonnes of carbon per unit of energy and then multiplied by 44/12 to convert to tonnes of CO_2; and
OF = An appropriate oxidation factor for that particular fuel, representing the percentage of carbon which is oxidised to carbon dioxide (e.g. the IPCC default value for coal is 0.98 [IPCC 1997b, p.1.8]).

Whilst it is technically feasible to measure fossil fuel combustion emissions of carbon dioxide directly, by continuous monitoring of gas flow rates and concentrations in the exhaust stack, such direct measurement is rarely used, as there is a very close correlation between the energy value of a fossil fuel and its CO_2 emissions (WBCSD & WRI [2001, p.36] assert that the accuracy of emissions estimation using the IPCC method is ±2-3% and that this exceeds the accuracy of direct monitoring). Similar methods can be used to estimate non-CO_2 greenhouse gases from fossil fuel combustion. While these are far less accurate, as actual emissions depend on locally-specific operating conditions and combustion and control technologies (IPCC 1997a, p.1.7), the amounts of these emissions from fuel combustion are

[27] Net calorific value (NCV) is also sometimes referred to as the lower heating value (LHV) of a fuel, and refers to the usable energy available after vaporizing the fuel's moisture. NCVs are approximately 95 per cent of the gross calorific value (GCV) for liquid fossil, solid fossil and biomass fuels, and 90 per cent of the GCV for natural gas (IPCC 1997b, p.1.9).

relatively small and, despite the higher global warming potentials of methane and nitrous oxide, together they make up a relatively small proportion of total carbon dioxide equivalent emissions from fuel combustion (e.g. <0.5% for anthracite coal combustion under IPCC default emission factors).

However, when the unit of interest is a whole company and not just a single fossil-fuel plant, many other methodological questions are raised, as related in this account of Ford Motor Company's early experience:

> "How should the company draw boundaries? How could acquisitions and divestitures be accounted for? What emissions factors should be used? And perhaps most importantly, how could the methodology be deemed credible with stakeholders? Although the team had no shortage of opinions, there also seemed to be no right or wrong answers…" (WBCSD & WRI 2001, p.12).

Many companies, including BP, Shell, Ford and Monsanto, experimented with assessing and reporting their greenhouse gas emissions through the 1990s. Towards the end of 1997, WRI and the World Business Council for Sustainable Development (WBCSD) agreed to launch an "NGO-business partnership to address standardized methods for GHG accounting".[28] The first, and to date still the most influential, standard produced under this partnership was *The Greenhouse Gas Protocol: A corporate accounting and reporting standard* (WBCSD & WRI 2001). The GHG Protocol uses the terms 'greenhouse gas accounting' or 'GHG accounting' rather than 'carbon accounting', and generally combines 'accounting and reporting', implying both internal management and external reporting functions. The ISO14064-1 standard is closely modelled on the GHG Protocol, and uses the terms 'quantification and reporting of greenhouse gas emissions and removals', 'GHG inventory' and – once – the term 'GHG footprint' (ISO 2006a).

A key function of the GHG Protocol was to assert certain boundaries of corporate responsibility for greenhouse gas emissions. It divided the boundary question into two components, organisational and operational. The guidance on setting organisational boundaries encourages companies to align their GHG inventory with the organisational boundaries already chosen for financial reporting purposes (WBCSD & WRI 2001, p.14). With respect to operational boundaries, a key innovation introduced by the GHG Protocol was the concept of three distinct operational scopes, as illustrated in Figure 9 below.

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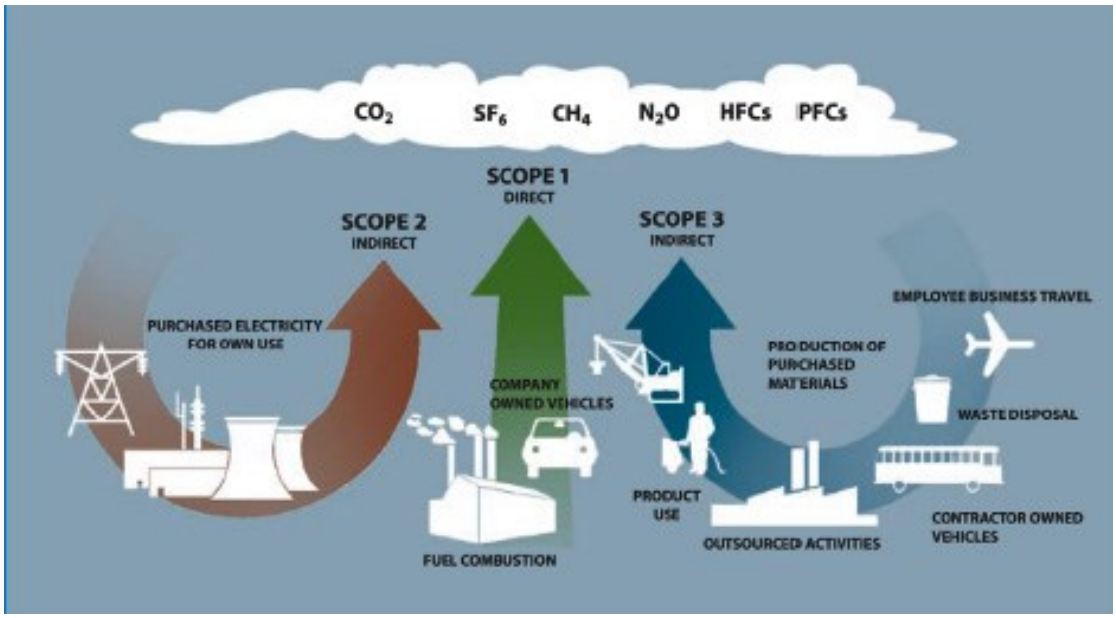
[28] See http://www.ghgprotocol.org/about-ghgp (accessed 18 December 2013).

Figure 9: The GHG Protocol's three operational scopes



Source: http://petrolog.typepad.com/climate_change/2010/01/reporting-ghg-emissions.html (accessed 31/12/2013). Note: this is simply a clearer version of the original graphic which appears in WBCSD & WRI (2004, p.26).

The rationale for these three scopes was to accommodate different notions of corporate accountability for emissions. Scope 1 corresponds with the version of accountability that informs the international framework of the Kyoto Protocol, where responsibility is allocated to the entity (country) that controls the point of emission to the atmosphere. Accounting on this basis has the advantage of being theoretically complete and non-overlapping. However, many corporations, particularly in service sectors, have relatively few direct emissions, but nevertheless consume energy and other goods and services, and produce other goods and services, which result in emissions to the atmosphere occurring elsewhere. The first version of the GHG Protocol simplified this problem by picking on the largest (global) contributor to anthropogenic greenhouse gas emissions: the energy sector, requiring companies to report the off-site or indirect emissions resulting from purchased electricity, heat or steam as 'scope 2', with all other potential upstream and downstream indirect emissions placed in a voluntary 'scope 3' category. In this way the problem of different understandings of corporate accountability, which could potentially lead to incoherence in different accountings, was delimited to some extent. However, while the GHG Protocol's concept of three operational scopes has been highly durable as an accounting construct, it can and is still challenged by alternative notions of accountability. For example, the logic underlying the primacy of scope 1, which is that control of the physical point of emission implies responsibility for that

emission, is challenged by those who argue that accountability should be based instead on the acts of consumption which cause emissions, regardless of where the emission occurs (Mózner 2013; Barrett et al. 2013). With respect to scope 2, an issue of current debate is whether or not to allow companies to apply a 'contractual' emission factor (CDP 2013) to their electricity consumption (for example because they have purchased renewable energy certificates or entered into a contract for 'green' electricity), rather than applying a consistent 'grid' emission factor relating more closely to the characteristics of the electricity grid from which they physically receive electricity (Defra 2009a).[29] A myriad questions about scope 3, such as whether to include upstream or downstream emissions, which goods and services to include, whether to include full life cycle emissions or a more limited scope, how to treat emissions occurring earlier or later in time, and so forth, led to development of a further standard specifically for scope 3 (WBCSD & WRI 2011a).

A term that was notably absent from the first edition of the GHG Protocol (WBCSD & WRI 2001) is 'carbon footprint'. Like carbon accounting, the term 'carbon footprint' is relatively new and interpreted differently in different contexts. Wiedmann & Minx (2007, p.3) observe that the term first entered the academic literature with three references in 2005, followed by 8 in 2006 and 31 in 2007, although none of these provided an unambiguous definition. It was included in the 2008 edition of the Chambers Dictionary, defined as "the impact of human activity measured in terms of the amount of carbon dioxide it causes to be emitted into the atmosphere."[30] However, the term was circulating in newspaper articles from at least 2000 (Safire 2008; Ercin & Hoekstra 2012) and a 2002 report by the New Zealand Business Council for Sustainable Development (NZBCSD 2002, p.17) states that "An emissions inventory is commonly termed a "carbon footprint"." It also appears once as 'GHG footprint' and twice as 'emissions footprint', each time in relation to examples of corporate practice rather than the standard itself, in the revised edition of the GHG Protocol (WBCSD & WRI 2004). I conclude that the term dates back to at least 2000, but what is remarkable is the way it took off in 2005-2006, becoming the most widely-used of all the key terms discussed in this chapter by 2007 (see Figure 6, p.109). I believe this reflects the point of inflection where, in Europe at least, corporate acceptance of the need to manage greenhouse gas emissions – starting with measuring one's carbon footprint (Hoffman 2007) – moved from being something associated with a relatively limited (if influential) set of leading

[29] For an insight into the current debate, see http://scope2openletter.wordpress.com/ (accessed 16 December 2013).
[30] Widely reported in the press; see for example http://www.ctvnews.ca/credit-crunch-carbon-footprint-enter-dictionary-1.316015 (accessed 30 December 2013).

companies, to the mainstream, influenced in particular by the ratification of the Kyoto Protocol and commencement of the EU ETS in early 2005.

Most commentators acknowledge some derivation from the concept of 'ecological footprint', developed in the early 1990s as a method of expressing aggregated environmental impacts in terms of the area of land required to sustain a given activity (Rees 1992; Wackernagel & Rees 1996). The concept of an ecological footprint includes a component (also known as CO_2 land or CO_2 area) that specifies the area of land that would have to be forested in order to sequester the carbon dioxide emissions from fossil energy consumption of a given activity (Global Footprint Network 2013), or, in its original formulation, alternatively to produce sufficient bioenergy to displace fossil energy (Rees 1992, p.126). However, it is fairly clear that this notion of carbon footprint, which essentially combines measurement of emissions with a rather arbitrary estimate of its offset equivalent in terms of forested land area, was soon overtaken by a more circumscribed understanding of carbon footprint as referring only to emissions measurement. Arguably, this more circumscribed metaphor has lost some of the original pedagogical power of the ecological footprint, which was achieved precisely by the translation of various, often not highly visible, impacts into a single, easily visualised metric of land area. As Bebbington et al. (2007, p.371) point out, the concept of the ecological footprint has the potential to "disturb and problematize the "normal" narratives of ecological modernization whereby minor improvements in efficiency are equated with being ecologically sound… An ecological footprint… does not mask power and conflict as it makes it very clear that some populations (primarily Western) are consuming far in excess of their "share" of biological resources." By contrast, a GHG inventory or product carbon footprint expressed in tonnes of CO_2 equivalent does not necessarily convey any sense of whether the amount represents any reasonable 'share' of an acceptable atmospheric loading of additional greenhouse gases. There is, for example, little evidence that carbon labels based on product carbon footprints are meaningful to consumers (Upham et al. 2011).

Wiedmann & Minx (2007, p.3) provide nine different definitions of 'carbon footprint' from eight grey literature sources (dated 2006 and 2007), which essentially fall into three groups, with the 'ecological' understanding of carbon footprint represented only by the Global Footprint Network. A larger set of definitions, promoted by corporates such as BP and BSkyB, corresponds to the idea of a corporate, organisational or household greenhouse gas inventory, as defined by WBCSD & WRI (2001) and ISO (2006). A third group, associated particularly with the UK's Carbon Trust, links to the concept of life cycle assessment (LCA)

and concerns the life cycle emissions from a product, process or service (Carbon Trust 2006; Carbon Trust 2008b; Carbon Trust 2008a; BSI 2008). LCA can be conducted in two different ways: through process analysis, a bottom-up method to calculate the environmental impacts of a given product by itemising its individual inputs and outputs and measuring or calculating their environmental impacts; and economic input-output analysis, a top-down method based on economic models which relate the economic activity of one sector to another in monetary terms, to which data on environmental impacts can be added (Wiedmann & Minx 2007). Process analysis LCA suffers from the difficulty of defining system boundaries, and complexity for all but the simplest products. Input-output LCA avoids these problems but loses detail, as it only captures the 'average' environmental impact of a sector, which may vary widely at the local level. The differences between the two methods mean that they are appropriate for different levels of analysis, from individual product or process to entire sectors or economies. Hybrid approaches are also possible, combining the granularity of process analysis with input-output analysis for secondary impacts.

East (2008, pp.4–5) provides a different set of definitions, which can nevertheless be divided into the same categories, and suggests that the term 'carbon footprint' is associated with a less rigorous, consumer oriented, and popularised version of corporate 'greenhouse gas accounting'. East's own definition of carbon footprint closely follows the concept of a GHG inventory in the GHG Protocol:

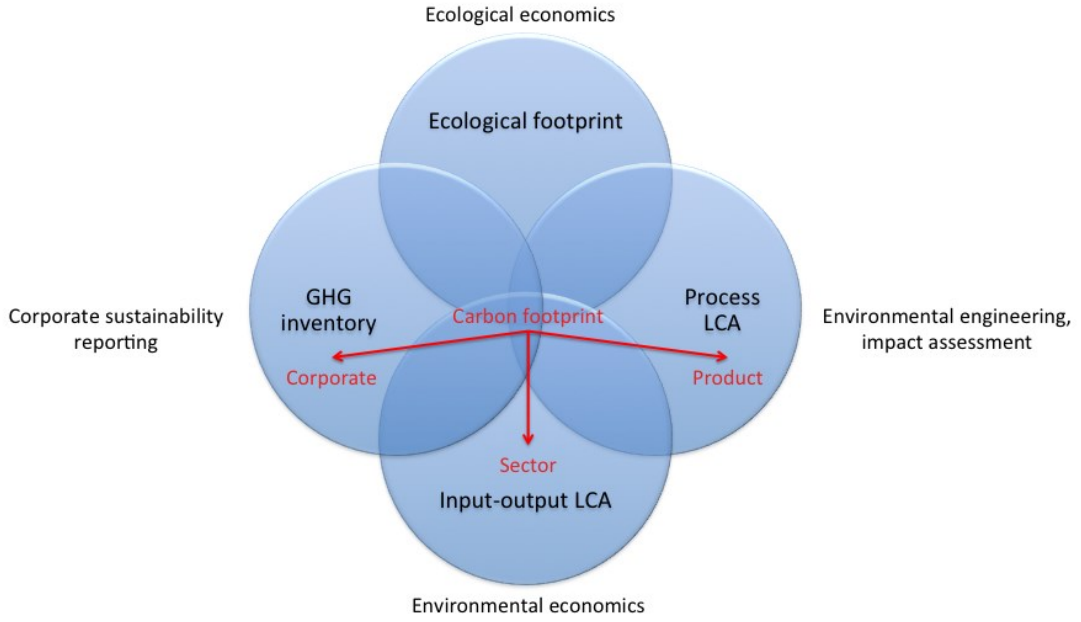
> "A direct measure of greenhouse gas emissions (expressed in tonnes of carbon dioxide [CO_2] equivalents) caused by a defined activity. At a minimum this measurement includes emissions resulting from activities within the control or ownership of the emitter and indirect emissions resulting from the use of purchased electricity." (East 2008, p.2).

These three groups of definitions of carbon footprint can be linked to different communities, illustrated in Figure 10 below: ecological economists in the case of the ecological footprint, advocates and practitioners of corporate sustainability reporting in the case of GHG inventories, environmental engineers in the case of process LCA, and environmental economists in the case of input-output LCA.[31] The influence of economics and engineering

[31] I do not wish to go deeply into the differences between 'ecological' and 'environmental' economics here, but my use of the two terms is intentional, as input-output LCA merely applies the tools of economics to measuring environmental impacts, whereas the ecological footprint actively seeks to change behaviour by highlighting the environmental unsustainability of present society.

on carbon accounting echoes similar influences on more conventional accounting practices such as Return on Investment and Net Present Value (drawn from economics) and standard costing and variance analysis (drawn from engineering) (Miller 2008, p.53).

Figure 10: Contested understandings of the term 'carbon footprint'



Source: the author.

Tensions can be discerned between these different communities, with respect to what a carbon footprint is, how it should be assessed and which community has the most relevant expertise. For example, an editorial in *The International Journal of Life Cycle Assessment*, announcing the launch of a special section on carbon footprinting in 2009, expresses the ire of the LCA community at being overlooked:

> "There are surprisingly many people out there that obviously think that carbon footprinting is a new thing. They obviously are not aware of the fact that it has been around for decades—just being called differently, i.e. the result of the life cycle impact category indicator global warming potential (GWP). However, carbon footprinting (CFP) is really fashionable these days." (Finkbeiner 2009, p.91).

Similarly, Mózner (2013, p.86) asserts that "The methodological root of the carbon footprint indicator goes back to the concept of "the energy cost of living" developed in the 1970s, and to net energy analysis (Herendeen and Tanaka, 1976)." Minx et al. (2009, p.188) make a similar claim for input-output analysis:

> "Given the recent interest in the CF [carbon footprint] concept, it is not surprising that many people seem to think that the CF concept is something new. While the term certainly is, the methodological frameworks to calculate CFs have been developed over a long period of time… A carbon footprint of a product, for example, is a necessary by-product of any life-cycle assessment… Products and process-based life-cycle assessment have received the most attention in the CF discussion so far. However, there are a variety of other relevant CF applications that require methodologies other than process analysis. With its focus on the direct and indirect emissions associated with a particular final demand, CFs are very intuitive for input–output (IO) practitioners. The methodological framework for input–output analysis was established in the 1970s… and at least since the late 1980s we find regular CF applications in the literature – albeit under different names."

The above quotations provide a sense of the professional competitiveness between different communities with respect to 'ownership' of the term carbon footprint. The corporate sustainability reporting community (represented by WRI and WBCSD) could be seen to have 'colonised' the process LCA community, with the issuance in 2011 of its own product LCA carbon accounting standard (WBCSD & WRI 2011b), building on earlier interventions by the Carbon Trust (Carbon Trust 2006; Carbon Trust 2008b; Carbon Trust 2008a; BSI 2008). In an editorial of a special issue of *Economic Systems Analysis* devoted to the application of input-output analysis to carbon footprinting, this community hits back with a series of counter-claims:

> "Carbon footprinting… needs economic input–output analysis. …input–output assisted carbon footprinting… is politically and economically relevant, from national greenhouse gas footprints down to product carbon labelling… there is still not a widespread acknowledgment of the potential for (hybrid) input–output analysis in other areas. Examples are corporate footprinting… and product carbon footprinting" (Wiedmann 2009, pp.175–176, 180).

Nevertheless, after reviewing a list of the many technical, methodological challenges invoked by carbon (LCA) footprinting, Finkbeiner (2009, p.92) acknowledges that it has the potential to provide a reflective learning opportunity for the LCA community:

> "Looking at this non-exclusive list of methodological issues reveals a very valuable aspect of the carbon footprint discussions and standardisation activities: the sobering recognition of very down-to-earth, basic scientific challenges for our community which have been getting a bit out of sight over the years. While most scientific attention was recently focussed on pushing impact assessment further… we now face the challenge that calculating a meaningful inventory result is not really solved—even for the probably

> easiest class of substances like greenhouse gases. …The scientific LCA community has been somehow escaping those fundamental challenges of how to define a system, how to treat allocation, how to deal with data, how to deal with recycling, etc." (Finkbeiner 2009, p.92).

This reflection can be seen as an example of the kind of positive learning that can result from conflicts between frames, when their existence is acknowledged and other understandings of an issue are appreciated.

5.3. A proposed expanded definition of carbon accounting

The preceding sections have shown that carbon accounting means many different things to different academic and practitioner communities, and moreover that the meanings of key terms have evolved over time, and continue to do so. I therefore use the term 'carbon accounting' as a provisional marker for something amorphous and contested, rather than seeking to reduce and contain its scope within a narrow, essentialised definition. Other terms such as 'greenhouse gas accounting' or 'climate change accounting' could also be used as such a marker, but I believe 'carbon accounting' is both more appropriate, and gaining wider recognition. The term 'carbon' is widely recognised as shorthand for carbon dioxide or greenhouse gases more generally, in addition to making more specific reference to elemental carbon in certain circumstances (Bebbington & Larrinaga-González 2008, p.714, note 1). 'Greenhouse gas accounting', whilst inclusive of carbon dioxide and all other greenhouse gases, neglects this latter aspect of accounting for elemental carbon. When a forest scientist carries out what they call 'destructive sampling' (IPCC 2003) (digging up entire trees, roots and all) they are interested in measuring the elemental carbon contained in the tree's biomass, not in accounting for greenhouse gases (at least, not directly). 'Climate change accounting' is sufficiently broad to serve as an umbrella concept for anything that could also be covered by carbon accounting, but its breadth is also a weakness, as it lacks reference to any of the physical quantities that underlie all of the forms of accounting that I have discussed in this chapter. I therefore regard it as a broader term that encompasses carbon accounting, rather than a direct alternative.

Although the meaning of carbon accounting is amorphous and contested, I believe it is possible to discern common features despite the many variations between different interpretations. In the first place, it clearly involves the application of calculative practices (Miller 1994; P. Miller 2001). Direct physical measurement is the foundational scientific basis for understanding the movements of carbon and greenhouse gases more generally through the biosphere. However, direct measurement quickly becomes impractical for many

applications, and is combined or replaced with modelling, estimation or calculation. When applied in a relatively consistent manner on an on-going basis, these practices constitute monitoring, which in turn provides a basis for periodic reporting. I include auditing as a general term, as well as validation and verification which have more specific meanings, both because I consider auditing to be an integral part of accounting generally, and because it plays such an important role in carbon offset accounting, such that carbon credits simply do not exist and therefore cannot be 'accounted' until they have undergone some kind of validation and verification, under most offset standards.

These calculative practices are applied to a variety of objects, unified by their common connection with a managerial response to climate change. In this chapter I have discussed accounting for physical carbon, carbon dioxide or other greenhouse gas emissions to and removals from the atmosphere, as well as stocks where carbon or greenhouse gases are stored over time, as the primary locus of interest for natural scientists. Starting with AES in 1989, accounting for carbon offsets began to involve an artificial construct: emission reductions or enhanced removals, where the quantity of interest is not a physical emission or removal, but rather the *difference* between this and a hypothetical baseline. The Kyoto Protocol in 1997, followed by other regulatory carbon markets such as the EU ETS, introduced accounting for legal and financial instruments – emission allowances, permits, credits conferring certain rights, and corresponding obligations – linked to, but again different from, physical carbon accounting. Once such instruments existed, further accounting practices emerged to do with accounting for transactions of these instruments. The fact that such instruments and transactions had monetary value meant that they raised issues of how to account for this in financial reports. More generally, companies such as BP, which experimented with implementing an internal emissions trading scheme from 1998 (Victor & House 2006) and Shell, British Gas and BHP, which began applying a shadow price of carbon to new investments from the early 2000s (Innovest 2003, pp.53, 57) are all engaged in accounting for financial equivalents of physical quantities. Taking things a step further, the Carbon Disclosure Project (CDP) represents the interests of stakeholders in corporate accounts not only of their physical emissions, but more generally of the impact of climate change upon a business, directly or indirectly via regulations, changing competitive pressures, litigation or reputational risk.

Accounting for these various objects can take place at many different levels, from the global carbon cycle down to the carbon footprint of a single product, and can be driven by a variety of either voluntary or mandatory purposes.

I therefore propose a ‘pick and mix’ definition, where carbon accounting can be understood as any combination (reading left to right) of one or more terms from each column in Table 5 below:

Table 5: Expanded definition of carbon accounting

measurement estimation calculation modelling monitoring reporting validation verification auditing	of	carbon carbon dioxide greenhouse gas	emissions to the atmosphere removals from the atmosphere stocks flows emission reductions enhanced removals legal or financial instruments linked to the above trades/transactions of any of the above financial equivalents of any of the above impacts on climate change impacts from climate change related actions, such as implementation of policies and measures	at	global national sub-national regional sectoral municipal household individual organisational corporate installation project programme policy activity event product process service supply chain building or other	level, for	mandatory voluntary	research compliance offsetting trading reporting disclosure benchmarking auditing information marketing or other	purposes

By combining terms in this way, more specific definitions can be derived and related to different forms of carbon accounting: for example, physical carbon accounting is primarily concerned with *estimation*, direct *measurement* or *modelling* of *carbon stocks* and *flows* or *greenhouse gas emissions* and *removals*, primarily at the *global* level, for *research* purposes, whereas carbon disclosure mainly involves *reporting* of *greenhouse gas emissions* and *impacts on and impacts from climate change* at the *organisational/corporate* level, for *voluntary disclosure* purposes (Ascui & Lovell 2011, p.980). The CDM quality assurance process entails *validation* and *verification* of *greenhouse gas emission reductions* or *enhanced removals* at *project* or *programme* level, for *mandatory offsetting* purposes (mandatory in the sense that such offsetting is driven by regulatory compliance, for example with Kyoto Protocol or EU ETS constraints on emissions, as opposed to purely voluntary offsetting). Companies covered by the EU ETS must *monitor* and *report carbon dioxide emissions* at *installation* level, for *mandatory compliance* purposes, while their financial accountants are involved in *calculation* and *reporting* of *financial equivalents of legal or financial instruments linked to carbon dioxide emissions* (i.e. EU ETS allowances and other allowable credits, plus associated liabilities) at the *corporate* level, for *mandatory disclosure* purposes. While it is not necessarily the case that every permutation could be linked to an existing practice of carbon accounting (I have not come across modelling of carbon stocks at an individual level, for example), most can be, reflecting the great diversity of practices of carbon accounting.

The diversity of partial definitions of carbon accounting from various sources collated in Stechemesser & Guenther (2012, p.27) supports the wide scope of this expanded definition. For example, Gifford & Roderick (2003) allude to the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 1997c) when discussing options for *measurement*, *estimation* or *modelling* of *carbon stocks* in soil at the *national* level for *mandatory* Kyoto Protocol *disclosure* purposes. Cacho et al. (2003) describe as "carbon accounting systems" (p.120) four different options for commensuration of *carbon removals* in forestry *projects* with emissions elsewhere, for *mandatory offsetting* purposes under the Kyoto Protocol. Ratnatunga (2007, p.8) states, "The mechanism for calculating the quantum of CO_2, either emitted by a source or sequestered in a biomass sink, is referred to as 'carbon accounting'." The author goes on to differentiate this from financial accounting of *legal or financial instruments* under emissions trading schemes; Hespenheide et al. (2010, p.57) observe a similar distinction, but argue that carbon accounting can mean either of these. Likewise, Bebbington & Larrinaga-González (2008, p.698) observe that at a minimum,

accounting for carbon involves financial accounting of new carbon-related assets and liabilities, but also discuss broader ways in which accounting is implicated in responding to climate change, for example through non-financial *reporting* of *impacts on and from climate change*, or climate change risks. Kolk et al. (2008, p.725) argue that the latter (which they characterise as carbon disclosure) is not the same as carbon accounting, which they equate with "a more precise, formal but narrower activity concerned with quantifying emissions that can be bought and sold in accordance with a particular set of legal standards and limits" – in other words, *trades/transactions of legal or financial instruments linked to emissions* of *carbon dioxide* or other *greenhouse gases*. Molisa & Wittneben (2008, p.178) provide the only definition within this set (excluding Ascui & Lovell [2011]) explicitly to recognise that carbon accounting can mean the *measurement* of *project-level emission reductions* for *offsetting*: "organizations will have to develop new accounting reporting practices capable of reliably measuring the carbon credits generated by a CDM project; an area that is increasingly coming to be called carbon accounting." Bowen & Wittneben (2011, p.1025) define carbon accounting as "the measurement of carbon emissions, the collation of this data and the communication thereof, both within and between firms" – yet go on to discuss a much wider scope than this, from the molecular to the societal level, with organisational carbon accounting in between (p.1033).

A further set of implicit definitions is also provided by Stechemesser & Guenther (2012, p.27). They cover similar ground to the previous explicit definitions, with additional mention of carbon *benchmarking* (Lovell & MacKenzie 2011, p.705) and of the need to develop a specific carbon accounting framework for cities, or what I have called the *municipal* level (Kennedy & Sgouridis 2011). Finally, Stechemesser & Guenther (2012, p.35) put forward their own over-arching definition:

> "Carbon accounting comprises the recognition, the non-monetary and monetary evaluation and the monitoring of greenhouse gas emissions on all levels of the value chain and the recognition, evaluation and monitoring of the effects of these emissions on the carbon cycle of ecosystems."

I agree with the generality of this definition with respect to its invocation of a range of calculative practices ("recognition, evaluation and monitoring") and levels, but would argue that its focus on "greenhouse gas emissions" as the relevant object of these calculative practices is too narrow, overlooking the fundamental qualitative differences between greenhouse gas emissions and other objects of carbon accounting such as carbon stocks or emission reductions, legal or financial instruments such as EU ETS allowances, etc.

In summary, I believe that the advantage of an expanded 'pick and mix' definition is that it highlights the wide diversity of new accounting practices which have arisen as society attempts to respond to the challenge posed by global climate change. Earlier definitions have tended to be limited to certain specific practices, although a trajectory of growing understanding and acceptance of alternative practices can also be discerned.

The expanded definition in Table 5 above differs slightly from that published in Ascui & Lovell (2011). In the first column, I have put measurement first and added the term 'modelling'. In the fourth column, I have added 'stocks' and 'flows' to the first set of physical quantities, and removed 'emission rights' and 'emission obligations', as they were already covered by 'legal or financial instruments linked to the above'. The terms 'stocks' and 'flows' are widely used by scientists to describe the carbon cycle, and by the IPCC in relation to accounting for LULUCF and carbon capture and storage (CCS) in particular (IPCC 1997c; IPCC 2003; IPCC 2005). It could also cover the recent surge of interest in stocks of fossil carbon (oil, gas and coal reserves) which could potentially become stranded assets in a carbon-constrained world (Leaton 2011; Leaton et al. 2013; ACCA & Carbon Tracker 2013). 'Enhanced removals' has been added as the equivalent (in the negative) of emission reductions. Other additions in this column include 'financial equivalents of any of the above' in order to more explicitly include the many ways in which monetary values can be used in carbon accounting, other than through accounting for carbon-related financial instruments (Burritt et al. 2011), and 'related actions' in order to encompass issues such as accounting for strategic management actions taken to address climate impacts, national implementation of climate policies, or monitoring international flows of climate finance promised by developed to developing countries (Huhtala et al. 2010; Buchner et al. 2011). Admittedly, this may be the point where the broader concept of climate change accounting becomes more appropriate, but I have included it for now, as there is the possibility that future frameworks for monitoring such actions may build on the accountability frameworks already better established for other forms of carbon accounting (see Prag et al. [2011]). The terms in column four have been arranged in four groups, each of which represents a further degree of abstraction building on the previous groups: physical quantities (emissions, removals, stocks and flows), hypothetical quantities (emission reductions, enhanced removals), legal or financial quantities and secondary effects (impacts and related actions).

In the sixth column, I have added further levels, including sectoral (the level at which many input-output studies operate, such as the accounts by economic activity produced by Eurostat[32] and the OECD), household, individual, programme, policy, activity, process, service, building and 'other'. Finally, I have added 'offsetting' to the list of purposes.

As already noted in Ascui & Lovell (2012), even such an expanded definition is inevitably incomplete – while on the other hand, it risks losing its value if it is too broadly inclusive. Nevertheless, I hope to have shown in this chapter that the terms included in my definition are of key significance.

5.4. Summary

This chapter aimed to clarify what carbon accounting is, in practice. It has shown that carbon accounting comprises a wide range of different practices, many of which have evolved in relative isolation from one another. Scientists can be understood as having carried out a form of carbon accounting (for the global carbon cycle) for over a century, with a more explicit understanding of the 'carbon budget' implications of rising atmospheric carbon dioxide levels from the mid-1960s onwards. However, other forms of carbon accounting arise from 1988 onwards – a critical period in which climate change transitioned from an issue of mainly scientific to wider social and political concern. The specific term 'carbon accounting' can be traced back at least to 1991, and is used initially by practitioners working to quantify the carbon stored and released in forests and other forms of biomass. Similar terminology is also used by practitioners involved in developing new national measures of responsibility for climate change – national greenhouse gas inventories, mandated under the 1992 UN Framework Convention on Climate Change. Since 2008, 'carbon accounting' has started to be used, in both academic and other literature, as a more generic term for other forms of carbon accounting, as I have used it in this thesis. The chapter also traces the early history of the key terms 'carbon offset' and 'carbon footprint', showing that the latter term, like 'carbon accounting' more generally, is understood differently and 'ownership' is contested by different communities. Finally, the chapter concludes that carbon accounting has been too narrowly defined by most commentators, and proposes an expanded 'pick and mix' definition that covers a much wider range of practices than previously considered within the scope of carbon accounting. As was observed of the academic literature in chapter 4, there

[32] See for example http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Air_emissions_accounts_statistics (accessed 3 November 2011). I am grateful to an anonymous reviewer of Ascui & Lovell (2012) for pointing this out.

appears to be considerable scope for the different communities involved in alternative practices of carbon accounting to learn from each other. However, this requires recognition of others' expertise and negotiation across boundaries between different communities, which I will return to in chapter 7.

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6. Making sense of carbon accounting

This chapter is based on work which has been published in Accounting, Auditing and Accountability Journal *as Ascui & Lovell (2011). The concept of five key frames of carbon accounting was jointly developed in discussions between myself and Heather Lovell, whose research at the time focussed on financial carbon accounting, whereas I was more engaged with what we eventually described as physical, political, market-enabling and social/environmental carbon accounting. The rest of this chapter contains the paper's main empirical material and is based on sections 1 and 4 of Ascui & Lovell (2011), edited for consistency with the rest of this thesis and including some additional unpublished material. I took primary responsibility for drafting these sections, apart from section 4.4 of the original paper (section 6.2.4 here, on financial carbon accounting) which was first drafted by Lovell and to which I provided secondary input and re-drafting. I have changed "we" and "our" to "I" and "my" throughout for consistency with the rest of this thesis.*

6.1. Introduction

The previous chapter has discussed the history of carbon accounting in practice, considering some of the key terms used by different communities and how these have changed over time as existing practices have changed and new practices have emerged. It argues for all of these activities to be considered collectively as 'carbon accounting' and puts forward an expanded 'pick and mix' definition that enables both common and distinct elements of different practices to be identified and related to each other. The purpose of the present chapter is to develop a broader conceptual framework that helps to make sense of these many different interpretations of carbon accounting, in particular when they conflict with each other. Faced with such an array of different conceptions of what carbon accounting actually is (and further conflicting views on who should do it, and how it should be done), one might conclude either that a select few are right and others are wrong, or that everything is relative and there is no basis for comparing alternatives. I suggest that neither of these conclusions would be helpful; rather, by understanding different practices of carbon accounting in their historical and social context, we can better appreciate the thinking behind different views, and are therefore able to have a constructive debate that is more likely to lead to real improvements on current practices. Policy controversies are notoriously difficult to resolve if the antagonists have completely different understandings of the problem and what might be considered an improvement – in other words, if they do not share a common frame of reference (Rein & Schön 1993). This chapter aims to clarify the major world-views or

frames of carbon accounting that shape different practices and perspectives on controversial issues, in order to facilitate more constructive 'frame-reflective' debate, as a vital enabler of more effective carbon management and markets.

Using the concept of framing as discussed in chapter 3, I believe we can classify different forms of carbon accounting according to five major frames: physical, political, market-enabling, financial and social/environmental carbon accounting. While there are overlaps between each of these frames, the purpose and function of carbon accounting in each frame is distinct. This can lead to the production of different accounts which may look superficially similar, but actually represent fundamentally different things. This can lead to misunderstanding and ultimately hamper climate change mitigation efforts. For example, in chapter 8 I discuss the differences in how carbon sequestered in UK forests is viewed by the owners of those forests and the UK Government, with the result that investment in such forests currently falls far short of its potential. The case study also mentions that there are early signs of a possible resolution of these differences, which has come about as a result of 'frame-reflective' research leading to identification of a compromise solution (Ascui & Neeff 2013).

To date, these five frames of carbon accounting have operated in relative isolation, with debates taking place *within* frames, rather than between them. I hope that 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.

In the next section, I summarise the key characteristics of the five distinctive framings of carbon accounting: physical, political, market-enabling, financial, and social/environmental carbon accounting. Within this, I provide brief examples of key tensions in different understandings of carbon accounting that illustrate the complexity of the issues under consideration. If unresolved, tensions such as these can have material negative consequences, and thus an improved understanding of the underlying causes of friction may contribute to finding workable solutions to climate change. As this conceptual framework has been in the public domain for three years already as Ascui & Lovell (2011), I conclude by considering how it has been received by practitioners and other researchers, in order to derive some independent assessment of the validity of this exploratory interpretive exercise.

6.2. The multiple frames of carbon accounting

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, p.6). To political negotiators, it implies "the rules for comparing emissions and removals as reported with commitments" at a national level (IPCC 2005, p.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 (UNFCCC 2013). 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 2010; WBCSD & WRI 2004; Defra 2009b). Over time, many different actors and disciplines have attempted to measure 'carbon' and its impacts in various ways, for a variety of different reasons. 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 (as discussed in chapters 4 and 5).

In this section I identify five major framings of carbon accounting, involving conceptual inputs from disciplines as diverse as earth sciences, economics, accounting and engineering. I 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. There are clearly frames within frames, and where to draw the line in order to identify the 'major' frames is open to debate. I do not suggest that

these five frames are beyond dispute, but rather aim to provide sufficient evidence to show that they exist, and that the differences between them are meaningful, by pointing out some of the key institutions, actors and social context which make up each of the identified frames.

6.2.1. Physical carbon accounting

The first frame can be characterised as the natural sciences view of carbon accounting as a matter of physical measurement, calculation, estimation and attribution of greenhouse gas fluxes through the biophysical environment. It has a long history: as discussed in section 5.2.1 of chapter 5, the first quantitative account of the global carbon cycle was put forward by the Swedish geologist Högbom in 1894. Because carbon cycles through the atmosphere, oceans, rocks and biological matter, its study involves atmospheric chemists and physicists, oceanographers, geologists and biologists, among others (collectively characterised as 'earth sciences'). Different frames or perspectives on carbon accounting could no doubt be identified between these disciplines, but at a higher level, they can be characterised as sharing a natural science paradigm and an interest in the physical characteristics of greenhouse gas emissions and removals, usually at a global level and without an immediate interest in social implications, such as attributing responsibility for such emissions and removals.

However, by the 1960s, increasingly accurate instrumental measurements of atmospheric carbon dioxide levels being made at the Mauna Loa observatory confirmed that concentrations were higher than pre-industrial levels, and rising (Pales & 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.[33] This can be seen as the founding moment for the second frame of reference, political carbon accounting.

[33] 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).

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 scientific literature see Chapter 2 in IPCC 2007a). Nevertheless, it is increasingly difficult, if not impossible, to maintain separation between the science and the politics of climate change, as demonstrated by the 'ClimateGate' furore over leaked emails from climate scientists 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 I provide in discussion of the other framings of carbon accounting. Conversely, scientists can become frustrated at the ways in which other forms of carbon accounting ignore physical realities in order to maintain other objectives, such as consistency with political objectives. For example, Searchinger et al. (2009) and Haberl et al. (2012) lament the introduction of a "critical climate accounting error" which treats combustion of biomass as carbon-neutral under the Kyoto Protocol and various national legislation, leading one study to conclude that:

> "a global CO_2 target of 450 ppm under this accounting would cause bioenergy crops to expand to displace virtually all the world's natural forests and savannahs by 2065, releasing up to 37 gigatons (Gt) of CO_2 per year (comparable to total human CO_2 emissions today)." (Searchinger et al. 2009, pp.527–8).

6.2.2. 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 et al. 1995; Guston 2000; Guston 2001). 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 (C. 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 1997c). 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.[34]

As C. Miller (2001, p.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 (C. 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 1997c). The need for standardised methodologies to enable comparisons

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

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; Shine et al. 2005; IPCC 2007a; 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 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. This was put forward by Lashof & Ahuja (1990), building on a similar concept developed to deal with ozone-depleting substances (Ozone Depletion Potential) which had led scientists working on these substances to consider their greenhouse warming potential in similar terms (Rogers & Stephens 1988; Fisher et al. 1990; Shine 2009).

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, p.529). In addition to being only one of several possible approaches (for others see Shine et al. 2005; 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; UNFCCC 2008b). 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 fourth IPCC assessment report suggests that a value of 25

times is more accurate – a variation of nearly 20% (Defra 2006; IPCC 2007a, p.212). If measured over a 20-year time horizon rather than the conventional 100 years, the GWP of methane rises to 72 (IPCC 2007a). These values have been revised upwards to 28 and 84, respectively, in the fifth IPCC assessment report (Myhre et al. 2013, p.714). These alternatives have major implications for where governments should direct their climate mitigation efforts, yet the political decisions over the choice of time-frame and other key assumptions 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" (p.27).

The GWP provides an excellent example of how an accounting concept seen as provisional and problematic in one community (natural scientists, atmospheric chemists in particular) can be uncritically accepted within the accounting practices of other communities (essentially, all other frames of carbon accounting tend to adopt these GWPs as 'given'), as they do not share the specialised knowledge that underpins a more critical assessment of the concept. The first IPCC assessment report explicitly put forward GWP as a simplified approach that *drew attention to* the difficulties of commensurating the impacts of different greenhouse gases, stating:

> "It must be stressed that *there is no universally accepted methodology* for combining all the relevant factors into a single global warming potential for greenhouse gas emissions. In fact *there may be no single approach which will represent all the needs of policy makers*. A simple approach has been adopted here *to illustrate the difficulties inherent in the concept*, to illustrate the importance of some of the current gaps in understanding and to demonstrate the current range of uncertainties." (Shine et al. 1990, p.58; my italics).

Nevertheless, this IPCC 'simple approach' became the "canonical definition" (MacKenzie 2009, p.445) outside the narrow domain of a particular community of climate scientists, where it was and continues to be hotly debated (Myhre et al. 2013). For example, an influential paper by the economist William Nordhaus observed, "A complication in studying climate change arises from the multitude of GHGs. In the analysis that follows, we translate each of the GHGs into its CO_2 equivalent." (Nordhaus 1991, p.921). Yet the actual conversion factors used are not included in the paper, nor is the fact acknowledged that they remained subject to debate and uncertainty. This is a classic example of 'black-boxing', which Latour (1999) defines as:

> "…the way scientific and technical work is made invisible by its own success. When a machine runs efficiently, when a matter of fact is settled, one need focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become." (Latour 1999, p.304).

Shackley & Wynne (1997) observe how the GWP concept lent itself to a market-based approach to minimising the economic costs of taking action to mitigate climate change. This brings us to the next frame, market-enabling carbon accounting.

6.2.3. 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, p.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 & 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 & 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.[35] 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 & Liverman 2009). There are now literally hundreds of CDM methodologies available for different types of project.[36] 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).

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[35] According to the legal firm Baker and Mackenzie, authors of the online rulebook available at http://cdmrulebook.org/ (accessed 18 December 2009).
[36] See http://cdm.unfccc.int/methodologies/index.html (accessed 8 January 2010).

As discussed in the previous chapter, 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 et al. 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, p.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 future climate agreement, under the new guise of 'REDD+', an acronym for the more cumbersome formula "reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".[37] Reduced deforestation remains a hotly contested area in market-enabling carbon accounting; one where the differences 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 & Ascui 2009; Eliasch 2008).

6.2.4. 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 $176 billion in 2011 (Kossoy & Guignon 2012).

[37] UNFCCC Decision 1/CP.3 [the 'Bali Action Plan'], paragraph 1 (b) (iii).

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 I 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 & IETA 2007b; Cook 2009; MacKenzie 2009; McGready 2008; Lovell et al. 2010; Lovell et al. 2013). 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 & Sanford 1996; critiqued in Milne 1996; see also Grinnell & 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; Lovell et al. 2010; Lovell et al. 2013; Lovell 2014).

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 (H. Lovell 2010b). 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 (H. Lovell 2010b). Indeed, their puzzled response to this line of questioning made it apparent that these climate change policy issues were outside their frame of reference.[38] Financial accounting for carbon is likely to remain contentious for many years to come, due to these fundamental conflicts between frames. Despite the IASB's re-launch of the Emissions Trading Schemes project in 2008 and listing of the topic at the top of its list of priority research projects following an agenda consultation in 2011 (IASB 2012, p.11) there is still no sign that an international standard on financial carbon accounting is forthcoming. In October 2013, after consultation on a proposed standard put forward by the French accounting standards body (Autorité des normes comptables 2012; EFRAG 2012), the European Financial Reporting Advisory Group concluded "the treatment of emission trading schemes does not seem to be perceived as a priority issue" (EFRAG 2013, p.10).

[38] Interview conducted by Lovell as one of a set of 20 interviews with accountants as part of a Nuffield Foundation supported research project (see Lovell & MacKenzie 2011).

6.2.5. Social/environmental carbon accounting

The last of the five frames emerges from the broader context of social and environmental accounting (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 can 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, p.200).

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, p.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 & 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), a widely followed corporate sustainability reporting framework. 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.

Chapter 5 (section 5.2.4) has discussed how companies such as BP, Shell, Ford and Monsanto began to experiment with assessing and reporting their greenhouse gas emissions in the 1990s, leading to 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 & WRI 2001; WBCSD & WRI 2004). While based in part on IPCC guidelines (i.e. political carbon accounting), the GHG Protocol introduced entirely new concepts relevant only to corporate emissions, such as the division between three scopes of emissions. 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 (ISO 2006a). However, as noted by Kolk et al. (2008, p.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 carbon disclosure.

One problematic boundary between the social/environmental and market-enabling frames of carbon accounting has to do with the accounting treatment of emission *reductions* – as opposed to emissions – in corporate carbon disclosures. The original version of the GHG Protocol (WBCSD & WRI 2001, pp.27–28) recognised three different situations where, it advised, reductions in emissions could be disclosed in the supporting information to a report on a company's greenhouse gas emissions: credited emission reductions within the company's selected operational boundaries (i.e. scopes 1, 2 or 3); credited emission reductions purchased from another organisation; and reductions resulting from changes in the reporting company's operations, which are nevertheless not captured in any of its selected operational boundaries. The 2004 version (WBCSD & WRI 2004, pp.58–61) provides additional guidance on avoidance of double-counting and stresses the importance of a clear distinction between reporting physical emissions and emission reductions or trades in any form of carbon credit:

> "It is important for companies to report their physical inventory emissions for their chosen inventory boundaries separately and independently of any GHG trades they undertake. GHG trades should be reported in its public GHG report under optional information—either in relation to a target… or corporate inventory…" (WBCSD & WRI 2004, pp.60–61).

In March 2014, after years of intensive lobbying from companies wishing to meet their emission reduction targets more cheaply, and from suppliers of 'green' electricity, the GHG Protocol issued a consultation draft (GHG Protocol & WRI 2014) of a new standard for accounting of scope 2 emissions (i.e. those resulting from an organisation's imported electricity, heat, cooling or steam consumption). The proposed new standard would require all organisations operating in markets where there is a choice of electricity product or supplier (such as the UK) to calculate and report scope 2 emissions in two different ways: one using a 'location-based' method based on application of grid average emission factors (the current approach) and the other using a 'market-based' method applying contractual emission factors (for example, reporting zero scope 2 emissions due to having a contract for 'green' or renewable electricity with an electricity supplier). While dual reporting according

to these two methods is proposed to be mandatory for organisations wishing to follow the standard, reporting entities are free to choose either of the two methods to measure progress towards voluntary targets and for passing on to other organisations in the supply chain (for example, a manufacturer could choose to use contractual emission factors to calculate the scope 2 emissions embodied in its products, meaning this in turn could be reported by a purchaser of those products, as its scope 3 emissions) (GHG Protocol & WRI 2014, p.11). If that were not complicated enough, because the market-based approach allocates parts of the total grid electricity generation to certain consumers, all other consumers will be required to report their market-based scope 2 emissions using a 'residual mix' emission factor, reflecting the average emissions from the remaining generation (GHG Protocol & WRI 2014, pp.46–7). It appears that the market-enabling frame of carbon accounting has 'overflowed' (Callon 1998a) into this area of social/environmental carbon accounting, with likely effects that seem at odds with the latter's original goals for GHG accounting and reporting to be relevant, consistent and transparent (WBCSD & WRI 2004, p.7).

No discussion of climate-change-specific corporate reporting would be complete without mention of the Carbon Disclosure Project (CDP), established 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 have gone '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.[39] 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.[40] 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 there is still little evidence of improvement on the preliminary analysis by Kolk et al. that

[39] See http://www.globalreporting.org/AboutGRI/FactSheet.htm and https://www.cdproject.net/en-US/Results/Pages/overview.aspx (accessed 24 September 2010).
[40] See for example http://www.corporateregister.com/

"...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, p.741). Nevertheless, the exercise may have more value for companies themselves, and the growing database also provides a basis for emergent forms of carbon benchmarking and indices, such as the FTSE CDP Carbon Strategy Index (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, p.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 markets. The opportunities created by the generation of carbon offsets for sale to other parties, or the use of such offsets to support claims of corporate carbon neutrality, may also have been influential (Kolk & Pinkse 2005; Lash & Wellington 2007; Lovell et al. 2009). The interaction between market-enabling and social/environmental carbon accounting has undoubtedly led to rapid emergence of standards and other institutions at the boundary between these two frames, something explored in further detail in the next chapter.

The above discussion has focussed on organisations, particularly private sector corporations, as the main subjects of social/environmental carbon accounting. However, as discussed in chapter 5, process and input-output LCA, as well as the earlier and broader concept of 'ecological footprint' (Rees 1992; Wackernagel & Rees 1996) have all made important and distinct contributions to the concept of the carbon footprint, and have also been applied at many different levels, particularly the national/sub-national/sectoral (for input-output LCA) and product, process or service level (for process LCA). These other forms of carbon accounting each have their own concepts, methods and expertise, associated with specific professions such as ecological economics or engineering. The question therefore arises as to whether it is appropriate to identify all of these together within a single frame. I believe that the differences are substantial enough for the four different communities contesting the

notion of 'carbon footprint' (summarised in Figure 10, p.133) to be considered as sub-frames, with their own conflicts; but a similar set of different accounting practices has for some time been widely accepted as being within the overall scope of social and environmental accounting. For example, Gray et al. (1993) include LCA – acknowledging it as a "domain of scientific and technical expertise" (p.175) relatively unfamiliar to accountants – alongside a variety of other methods of accounting for the environment based more firmly around the corporation as reporting entity. At the scale of difference represented by the other four frames in my analysis, I believe there is sufficient common ground to justify grouping these disparate sub-frames together as social/environmental carbon accounting. However, it is still worth paying attention to sub-frame conflicts. For example, the more 'scientific' perspective of those typically involved in LCA perhaps helps to explain why the PAS 2050 standard for carbon accounting of goods and services (BSI 2008) specifies the use of the *latest* IPCC figures for global warming potentials – as opposed to the more 'political' perspective of the GHG Protocol or Defra corporate reporting guidance (Defra 2009b), both of which follow the Kyoto Protocol convention of using 1996 IPCC values. It is also worth remembering that a relatively subtle conceptual difference such as this would give rise to discrepancies between, for example, a company's reported emissions and the aggregate emissions associated with the company's products (even if all other aspects of scope and coverage were the same). 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 2008b). 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.

6.3. Summary

Carbon accounting is not merely a set of diverse, loosely related practices. These different practices represent fundamentally different conceptions of what carbon accounting is, how it should be done, and by whom (the last point being explored further in the next chapter). Because climate change is a 'super wicked' global problem (Lazarus 2009), and because carbon accounting is critical to enabling an effective societal response to the problem, these different conceptions *matter*. For example, whether biomass is treated as carbon neutral or not can affect management decisions at all levels, from companies choosing between renewable energy technologies to governments setting biofuel or bioenergy policies. Whether methane is considered to be 21 times as powerful a greenhouse gas as carbon

dioxide (under the current Kyoto Protocol convention), 28 times (according to the latest IPCC report) or 84 times (according to the latest IPCC report and using a 20-year time horizon) clearly makes a vast difference to the relative emphasis that should be placed on mitigation responses between greenhouse gases. Appreciating that our responses depend on different conceptions of carbon accounting, and understanding where these conceptual differences come from, is therefore important as a first step towards more constructive dialogue, mutual learning and the creation of more effective responses to climate change.

There is tremendous potential for misunderstanding at the intersections of different frames of carbon accounting – 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, pp.7–8; my italics). 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 allowances 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.[41] Such nuances should provide fertile material for further SEA research in financial carbon accounting.

This chapter has drawn on the concept of framing (Goffman 1974; Rein & Schön 1993; Callon 1998a) to help make sense of this situation. Five major frames of physical, political, market-enabling, financial and social/environmental carbon accounting have been identified. This is undoubtedly a drastic simplification (as the many different practices and definitions

[41] I am grateful to Navraj Singh Ghaleigh of the University of Edinburgh Law School for this insight.

of carbon accounting mentioned in both this and the previous chapter could potentially represent dozens of different frames) but they represent key world-views that can be associated with different objectives, terminology, methods, institutions and expertise that together characterise distinct communities of practice (discussed further in the next chapter). There are relationships between frames, with the first four essentially building on each other, whereas social/environmental carbon accounting draws from multiple sources – yet the rapid evolution, proliferation and complexity of carbon accounting practices has led to compartmentalisation of knowledge and expertise, such that what is problematic within one frame may well be uncritically accepted within another, or vice versa. This chapter has by no means comprehensively delineated the boundaries between each of the five frames, but it has drawn attention to the existence of a number of specific controversies and 'overflows' (Callon 1998a), which could benefit from further frame-reflective analysis.

6.4. Postscript

One way to judge the validity of an interpretive effort to make sense of a social phenomenon is to examine its reception by other people. I am able to make an initial assessment of the contents of this chapter because it has been in the public domain for three years in the form of Ascui & Lovell (2011). The concept of different frames of carbon accounting seems to have resonated with a wide range of people, from different disciplines, including both academics and practitioners.

From an academic perspective, the paper was published in a special issue which was subsequently awarded Emerald's 'Outstanding Special Issue Award' for 2012, with the AAAJ editors (Guthrie and Parker) noting "the early signs are there that the introduction and a number of the papers will make it into our AAAJ top ten downloads".[42]

At the time of writing (April 2014) the paper had been cited 26 times in Google Scholar. Academics have referenced the work in relation to carbon accounting meaning different things to different people (Larrinaga 2014; de Villiers et al. 2014; Gibassier & Schaltegger 2012), financial carbon accounting in particular (Haupt & Ismer 2013; Wright 2013; Lovell et al. 2013), communities of practice and the Climate Disclosure Standards Board (Andrew & Cortese 2013), how critical scrutiny of competing perspectives can lead to constructive learning (Saravanamuthu & Lehman 2013) and the general challenges that climate change

[42] See http://www.emeraldinsight.com/authors/literati/si_2012.htm?view=normal (accessed 13 October 2012).

creates for accounting and finance (Hoffman & Ehrenfeld 2013). It has also been referenced as an example of the use of framing as a theoretical lens (Dahanayake 2013; Asplund 2014).

Most of the authors named above can be either closely or loosely associated with either the social/environmental or financial frames of carbon accounting, but another paper referencing the work stands out as an example of cross-frame collaboration, involving an eminent geologist and climate scientist, Gregg Marland, collaborating with another scientist (Thomas Buchhholz) and an academic accountant (Tammy Kowalczyk) on a paper entitled 'Accounting for carbon dioxide emissions: The context and stakeholders matter' (Marland et al. 2013). Marland has "served as a member of the National Research Council Committee on Methods for Estimating Greenhouse Gas Emissions, [and as] co-chair of the United State Interagency Carbon Cycle Science Working Group", in addition to being a lead author on a variety of IPCC reports.[43] He has authored numerous key papers in the 'physical' carbon accounting literature, from the 1970s to the present (e.g. Marland & Rotty 1978; Marland & Rotty 1979; Marland et al. 2001; Sedjo & Marland 2003; Peters, Marland, et al. 2012). It is therefore significant to see the paper starting with this reflection:

> "Accounting for carbon dioxide (CO_2) emissions is no longer just counting carbon atoms. It turns out that *how you account for CO_2 emissions and the answers you get depend on the questions you ask, the framework of the query*.
>
> "There are now many who care about accounting for CO_2 emissions: from scientists interested in the global carbon cycle to environmentalists concerned about global climate change, regulators overseeing international or subnational agreements, businesses concerned about regulations or public good will, traders interested in markets for emissions permits, stockholders concerned about corporate risk, and good citizens just wanting to do the right thing. But there is not a single answer for all questions, and for many questions, we do not have a consensus on how the accounting should be done." (Marland et al. 2013, p.340; my italics).

The paper goes on to acknowledge, "The existence of contending accounting frameworks has been recognized by Ascui and Lovell…" and develops two examples (one to do with accounting for biomass, the other to do with entity-level carbon accounting) where different framings lead to radically different views of the problem and what should be done about it. This is exactly the sort of 'frame-reflective' learning (Rein & Schön 1993) that the paper

[43] See http://geology.appstate.edu/faculty-staff/gregg-h-marland (accessed 12 December 2013).

advocated, as well as an excellent example of cross-disciplinary learning and collaboration (between physical scientists and accountants).

With respect to practitioners, the paper's concept of five key frames of carbon accounting has been adopted by the Climate Disclosure Standards Board (CDSB), and incorporated into the opening slide of the standard CDSB presentation template (see Figure 11 below). This was then used to introduce debate at a meeting of the All-Party Parliamentary Group on Climate Change in November 2011 on the topic of 'Consistency in Climate Change Disclosure for Better Decision Making'.

Figure 11: Slide 1 of CDSB presentation template, December 2011

Last but not least, I have used the conceptual framework in this chapter to help structure a Masters course on carbon accounting that has run at the University of Edinburgh since 2011. The concept of five key frames provides the introduction and overall framework for a course which ranges across organisational carbon footprinting, national greenhouse gas inventories, carbon disclosure, benchmarking, product and supply chain carbon accounting, financial accounting, auditing and tax treatment. As far as I am aware, this is the first such Masters-level course in the world. Students are excellent critics, and I count the fact that the

conceptual framework has stood up to their scrutiny for three years in a row as strong support for it making sense.

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7. Carbon accounting and the construction of competence

This chapter is based on work which has been published in a special issue of the Journal of Cleaner Production *as Ascui & Lovell (2012). The chapter contains the paper's main empirical material and is based on sections 1 (excluding 1.1), 3 and 4 of Ascui & Lovell (2012), edited for consistency with the rest of this thesis and including some additional unpublished material. I took primary responsibility for drafting the paper as a whole, but I drew on empirical material (interviews and participant observation at meetings of the Climate Disclosure Standards Board) provided by Heather Lovell, in addition to my own analysis of documentary sources and practitioner experience.*[44] *I have changed "we" and "our" to "I" and "my" throughout for consistency with the rest of this thesis.*

7.1. Introduction

The previous two chapters have shown that carbon accounting involves a highly diversified set of practices which can be grouped into five major frames or world-views which are inter-related, yet conceptually relatively isolated from one another. Each frame can be associated with different objectives, terminology, methods, institutions and expertise that together characterise distinct communities of practice. The present chapter sets out to examine who are the principal communities involved in carbon accounting, and how they interact, particularly with respect to how claims of relevant expertise or competence are extended by different communities, and how the boundaries between communities are negotiated.

As climate change has risen up the policy agenda over the past twenty years, the financial stakes associated with carbon accounting expertise and the definition of standards have increased. For example, in 2013, 403 companies in the Global 500 reported a total of 3.6 $GtCO_2e$ in scope 1 and 2 emissions to the CDP (PricewaterhouseCoopers 2013). In the UK, as of 30 September 2013, around 1,100 companies are now affected by mandatory greenhouse gas reporting requirements under the Companies Act 2006 (Defra 2011b; Defra 2013). Influencing how such companies measure and report their emissions, and gaining access to the funding allocated for such measurement, reporting and subsequent carbon management represents a sizable business opportunity. Carbon measurement, management and reduction was identified as the number one opportunity area for UK consultants in a recent survey (ENDS 2010). Other significant business opportunities have been present in

[44] I joined the Climate Disclosure Standards Board Technical Working Group in December 2013. However, this chapter was drafted before then and I have only made use of my own experience to cross-check assertions made on the basis of Lovell's previous participant observation.

carbon markets, where transactions reached a peak of US$148 billion in 2011 (Kossoy & Guignon 2012). It is therefore plausible that there might be emerging tensions between different communities over the limits and boundaries of professional expertise, control over the content and process of standards development, and attempts to link new forms of carbon accounting to existing areas of professional practice. A process of "discursive competition" through which the accounting profession sought to extend its claims of expertise into the new field of environmental auditing in the 1990s has been documented by Power (1991; 1996; 1997). Similar processes may be expected to occur with respect to carbon accounting, where the potential economic scale and transformative impact easily surpasses that of environmental audit, making these processes all the more worthy of close examination.

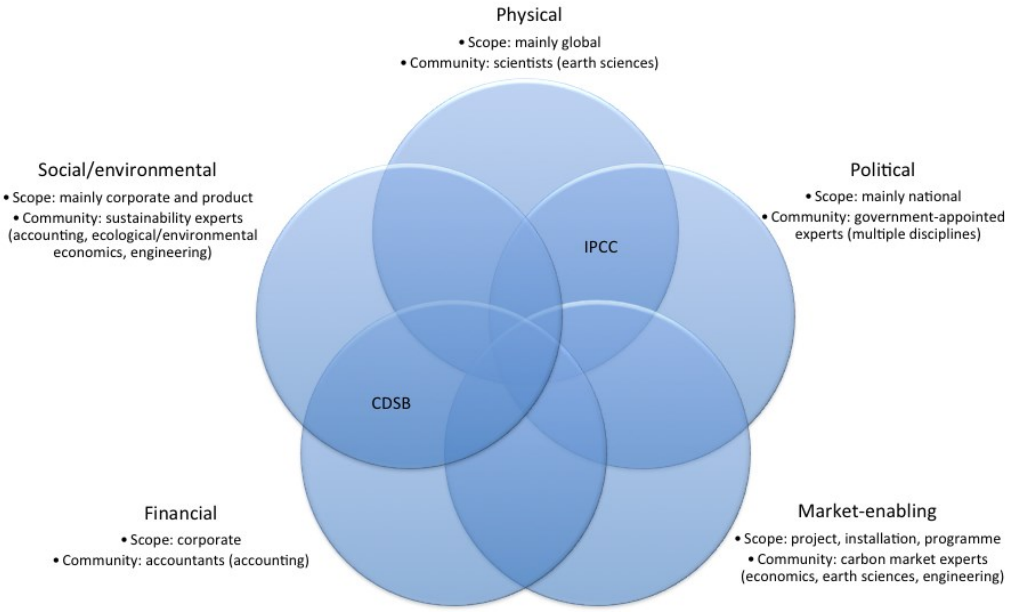
The chapter is organised as follows. Section 7.2 outlines the communities and key disciplines or professions associated with each of the five frames identified in chapter 6, drawing on the concept of 'epistemic communities' (Haas 1992b) introduced in chapter 3. Section 7.3 explores in more detail the discursive positioning of the accountancy profession with respect to carbon accounting, and the rhetorical devices (boundary-work) being employed to extend the boundaries of their expertise and to influence policy. Finally, a case study is presented in section 7.4, where I examine the actors involved in the establishment of the Climate Disclosure Standards Board (CDSB) in 2007 and the development of its Climate Change Reporting Framework (released as an Exposure Draft in 2009 and published in September 2010), arguing that the CDSB appears to be a 'boundary organisation' linking two epistemic communities. One of these communities consists of people who are motivated by environmental concerns (albeit from an investor perspective), with an interest in expanding the scope and quality of carbon disclosure as a means towards improving carbon management and thus reducing greenhouse gas emissions, while the other consists mainly of individuals from accountancy professional bodies and the 'Big Four' global accountancy firms, who, as a profession, have a financial interest in the provision of services in support of carbon disclosure. Their cooperation seems to advance both sets of interests, but a consequence is that although the scope of the CDSB's Climate Change Reporting Framework covers only non-financial information on greenhouse gas emissions and strategic responses to climate change, it is presented in a format and via technical terminology that clearly aligns it with the existing financial reporting competence of accountancy professionals. The chapter's main conclusion is that the accountancy profession is currently engaged in a major, as yet largely un-scrutinised, initiative to extend its claims of relevant

expertise in carbon accounting, through a variety of methods including the promotion of standards linking carbon disclosure to existing competence in financial reporting.

7.2. Communities involved in carbon accounting

The five major frames of carbon accounting identified in chapter 6 are, of necessity, relatively high level and generic. Nevertheless, I believe that each can be associated with a typical scope or level of carbon accounting, and a particular community of practice, even if some of these communities are likewise high level and generic. This is illustrated in Figure 12 below.

Figure 12: The five major frames of carbon accounting, with associated scopes, communities and disciplines



Source: the author, based on Ascui & Lovell (2011).

It now seems fairly widely acknowledged (Guenther & Stechemesser 2011; Bowen & Wittneben 2011; Ascui & Lovell 2011) that physical carbon accounting, conducted primarily by scientists and scientific organisations, is a distinct field of practice. Physical carbon accounting may be carried out at almost any level, but is typically global in its implications, as the carbon cycle is global. As discussed in chapter 6, many scientific disciplines are involved in physical carbon accounting, but they are generally those grouped together as 'earth sciences'.

What I have termed 'political' carbon accounting under the UNFCCC differs from most scientific measurements in being bottom-up, usually based on existing national statistics for factors such as fuel consumption, deforestation rates and numbers of livestock, combined with assumed emission factors per unit of each activity, as opposed to top-down direct measurement or modelling. The actors involved in 'political' carbon accounting include both physical carbon accounting specialists and government officials, usually drawn from the government agency or department with lead responsibility for environmental issues generally (pers. comm., UNFCCC reporting expert, 17 March 2014). In practice, much of the government role is often contracted out to technical consultants: for example, in the UK, the national greenhouse gas inventory is compiled by sustainability consultants Ricardo-AEA, with inputs from additional consultants and scientific research centres.[45] National political representatives act as 'gate-keepers' controlling participation in 'political' carbon accounting: for example, a candidate for the UNFCCC Roster of Experts in the area of greenhouse gas inventories must be nominated by a National Focal Point (official government representative) according to specified criteria which include relevant scientific and technical expertise, academic or professional qualifications and at least five years of experience.[46] To date, accountants from the 'Big Four' global accountancy practices have not generally been heavily involved in 'political' carbon accounting.

The interface between physical and political carbon accounting is analogous to the more general science-policy interface, the analysis of which first gave rise to the concepts of both epistemic communities and boundary-work (see chapter 3). It is straddled by boundary organisations such as the Intergovernmental Panel on Climate Change (IPCC), which in addition to mediating between climate science and politics (C. Miller 2001; Fogel 2005) has a specific role in providing the "comparable methodologies" which countries must follow for national carbon accounting under the UNFCCC (Article 4.1 [a]).

Although carbon markets were originally conceived at the national level (under the Kyoto Protocol) most of the actual activity of market-enabling carbon accounting involves monitoring, reporting and verification at the project, installation or programme level (generally, project-level and, more recently, programme-level accounting is associated with baseline-and-credit schemes such as the CDM, whereas installation-level accounting is

[45] See http://naei.defra.gov.uk/about/naei-team (accessed 29 April 2014).
[46] See http://unfccc.int/parties_and_observers/roster_of_experts/items/534.php (accessed 10 December 2010).

associated with cap-and-trade schemes such as the EU ETS). While market-enabling accounting at the national level is essentially a further development of political carbon accounting, involving similar actors, the actors involved in market-enabling carbon accounting at the project, installation and programme level are new and diverse, represented by organisations such as the International Emissions Trading Association (IETA), the CDM Project Developer Forum and Climate Markets and Investors Association (CMIA).[47] All of the 'Big Four' global accountancy firms are members of IETA, and KPMG and PwC are also members of CMIA. However, their engagement has not been uniform: for example, only PwC has had significant direct involvement in the preparation of new project-level carbon accounting methodologies, proposing 14 out of 339 new methodologies for large-scale emission reduction projects considered by the CDM Executive Board up to the end of March 2011 (KPMG was peripherally involved in a further two proposals).[48] This work is also not evenly distributed: although PwC has acted as consultant for the development of project design documents for 117 emission reduction projects, making it the sixth most experienced consultant by number of projects[49], this work is concentrated almost exclusively in the PwC India office. In general, it is probably fair to say that the involvement of the accountancy profession in market-enabling carbon accounting has mainly been on a rather ad-hoc consultancy basis, reflecting their broad transactional experience rather than a claim for specific expertise in this type of carbon accounting. From my own experience within it, I would say that the community of carbon market experts is eclectic with respect to disciplinary backgrounds, but economics, earth sciences and engineering dominate in different parts of the business (e.g. economics in carbon trading but earth sciences or engineering in project development and monitoring).

Financial carbon accounting is clearly associated with the corporate level and with the community and discipline of financial accounting. I expand on the role of financial carbon accounting as an entry point for the accountancy profession into other forms of carbon accounting in the next section.

Social/environmental carbon accounting can be applied at almost any level, but the largest amount of activity appears to have taken place at corporate (within the broader set of

[47] See http://www.ieta.org/, http://www.pd-forum.net/ and http://www.cmia.net/ respectively (accessed 10 December 2010).
[48] Based on data from UNEP Risoe Centre CDM Pipeline spreadsheet, available at http://cdmpipeline.org/publications/CDMPipeline.xlsx (accessed 1 April 2011).
[49] Ibid.

organisational) and product levels. While I believe that practitioners of social/environmental carbon accounting can be characterised as belonging to a community of sustainability experts, there is less cohesion and greater diversity within this in comparison to the other communities identified in Figure 12. For example, in chapter 5 I discussed the contributions of ecological/environmental economists and engineers to the concept of the carbon footprint. Within organisations, individuals with different sorts of expertise may work on producing physical versus monetary carbon-related information, for internal (management) versus external accounting and reporting purposes (Burritt et al. 2002; Schaltegger et al. 2006; Schaltegger & Burritt 2010). Burritt et al. (2011) draw further distinctions not only on the basis of physical and monetary dimensions, but also according to the time-frame of decision-making, the length of time-frame, and the routineness of the information supplied. One of their empirical observations (based on interviews with a set of ten large German companies) is that many different functional managers within an organisation may be involved in collecting, processing and acting on both physical and monetary carbon-related information. Although such functional managers (typically energy, environment/sustainability or carbon managers) are in effect carrying out accounting functions, they would generally not identify themselves as accountants, and in fact a unifying, coordinating role (which might be played by accountants) is typically absent (Burritt et al. 2011). This observation supports earlier work which has found little or no standardisation of approaches within organisational carbon management (Kolk & Pinkse 2005; Kolk et al. 2008).

I summarise what I believe are the key forms of organisational carbon accounting in Figure 13 in section 7.4 below. For reasons which will become clearer during my discussion of the Climate Disclosure Standards Board in section 7.4, I suggest that the collection, processing and reporting of strategic carbon management information should be considered an intermediate or overlapping category, as it typically involves a combination of both physical and monetary measures. I have termed this ‘strategic carbon management accounting’ when the focus is internal, and ‘climate risk, opportunity and governance disclosure’ when the focus is external. To some extent the former category also recognises a call made by Ratnatunga and Balachandran (2009) to distinguish between carbon-related cost management and strategic management accounting activities.

Turning to external, physical carbon accounting at the organisational level, one can observe that although accountants have had some involvement in the development of standards in this area, a wide range of other actors have also been active. For example, of nearly 350

acknowledged contributors to the 2001 edition of the main industry standard for corporate carbon footprints, the GHG Protocol, only 21 can be clearly identified (by their organisational affiliation) as professional accountants (WBCSD & WRI 2001). Amongst the broader field of contributors, accountants are outnumbered by specialist carbon footprinting companies (usually small to medium size) and share the platform with general management consultancies and engineering consultancies, as well as a host of non-governmental organisations (NGOs), government agencies, intergovernmental bodies, trade associations, research institutions and (mainly carbon intensive) businesses. Anecdotal evidence as well as personal experience in the corporate carbon accounting market suggests that this is also a reasonable reflection of the range of actors who have subsequently carried out carbon footprints or corporate greenhouse gas inventories. Over time, there has been some degree of evolution from dominance by small specialist consultancies, NGOs or research institutions (commonly brought in to help undertake the first footprint of an organisation or product) through to this becoming incorporated within the organisation's routinely generated internal management accounting. At the same time, carbon footprinting has also become a standard component of the services provided by the advisory arms of the global accountancy firms (which have in certain cases acquired small carbon footprinting specialists for this purpose[50]), and by various general management and engineering or environmental consultancies.

Similarly, the fast-growing field of product carbon footprinting and labelling was initially dominated by technical specialists and supported by quasi-government bodies such as the UK's Carbon Trust (Sinden 2009), but now can be found as a standard service offered by accountancy firms such as Deloitte.[51] I have previously noted that product carbon footprinting has a different pedigree to organisational carbon footprinting, with roots in LCA and input-output analysis, both of which are associated with more specialised technical competence than organisational carbon footprinting. Thus product and supply chain carbon footprints tend to be carried out by specialist consultancies, working with technical staff within organisations responsible for buying or manufacturing the products in question.

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[50] For example, one of the stated purposes of the acquisition of dcarbon8 by Deloitte in March 2010 was to "provide Deloitte a route into the market for carbon footprinting services" (Datamonitor, 4 March 2010).

[51] See http://www.deloitte.com/view/en_GB/uk/market-insights/sustainability-services/climate-change-and-carbon-management/carbon-footprinting-and-reduction-services/index.htm (accessed 24 October 2011)

In summary, of the five frames, social/environmental carbon accounting seems the most open to contested claims of 'ownership' and expertise, as it involves the least cohesive community. The corporation represents a site of potential conflict between the communities of financial carbon accounting (indisputably the domain of accountants) and social/environmental carbon accounting, where accountants share the field with a range of specialist and generalist consultancies as well as internal functional managers, whose expertise is more likely to draw on the disciplines of ecological/environmental economics or engineering. After financial carbon accounting, the various forms of internal carbon management accounting might be assumed to be the logical place for deployment of traditional accountancy expertise, but as Burritt et al. (2011) note, there is little evidence of this, as yet. On the other hand, accountants have been competing more actively with other specialists in the field of carbon disclosure. A possible explanation may be that external pressure to disclose, driven by demands from regulators, investors or other stakeholders, is the most important driver of carbon accounting activity at present, while routine internal management controls have yet to catch up with and incorporate these new developments. The next section traces the involvement of the accountancy profession with carbon accounting in more detail.

7.3. Accountants and carbon accounting

Lovell and MacKenzie (2011) characterise the period from the late 1990s to 2005 as one of 'reluctant engagement' of accountants with climate change. During this period, detailed technical debate on financial carbon accounting took place largely behind closed doors and without drawing links to the wider issue of responding effectively to climate change. For example, in November 2003 the Emerging Issues Task Force (which advises FASB, the US-based Financial Accounting Standards Board) met to discuss *Issue no. 03-14, Participants' Accounting for Emissions Allowances under a "Cap and Trade" Program*, and considered it relatively non-contentious, removing it from the agenda after a single meeting. In fact, some members indicated that "they did not perceive a practice issue or diversity in the accounting for emissions trading programs" (FASB Emerging Issues Task Force 2003, p.76).

At the same time, a number of accountancy professional bodies were working to raise their members' awareness of climate change and other sustainability accounting issues more generally. A 2004 report by The Institute of Chartered Accountants in England and Wales (ICAEW) entitled *Sustainability: The role of accountants* included an entire chapter on

tradable permits, with sections on recognition, measurement and reporting (both in physical and financial terms), concluding that:

> "At present, very few professional accountants are familiar with the [these] schemes… and there is a challenging opportunity for the profession to contribute to the development and implementation of policy at all levels, as well as standards for accounting and reporting… Whilst the initial measurement is a matter for other specialists, there will be a substantial role for accountants in reviewing information, assessing the implications and contributing to the operation of related markets." (ICAEW 2004, pp.66–7).

There was by no means an immediate response by the accounting profession to the ICAEW report, as illustrated in this October 2009 interview with the manager with responsibility for sustainability issues at ICAEW:

> "I suppose what we were doing with [the ICAEW (2004) report] was carving out a role for the profession, trying to identify it ... and saying to members "Look, here is a role for you, and *tell us what skills we need to build for you so you can occupy it.*"
>
> Interviewer: And what sort of a reaction did you get?
>
> Well, I'd say four and a half years ago the reaction was puzzled bemusement! I think members struggled—and still do to an extent—to see what their role is..." (Lovell & MacKenzie 2011, p.715).

In summary, during this first phase, efforts can be discerned, led by accountancy professional bodies, to re-frame the issue (i.e. "policy innovation," in the language of epistemic communities), but without managing to achieve the next step of "policy diffusion" (Adler & Haas 1992).

Since 2005, however, the pace of policy diffusion activities such as the publication of reports, development of standards and growth in disclosure initiatives has quickened, in what Lovell and MacKenzie term the 'strategic engagement' phase. A key factor in this transition was the controversy generated by the publication by the International Accounting Standards Board (IASB) of *IFRIC Interpretation 3: Emission Rights* (IFRIC-3) in late 2004, which elevated financial carbon accounting from a technical issue discussed in meetings of accounting standards bodies to a very real issue for thousands of practicing accountants in European companies, with significant financial implications (for a full explanation, including how IFRIC-3 was withdrawn six months later, see Cook [2009]). This in turn drew the attention of the 'Big Four' accountancy firms, which published reports promoting their

advisory competence in this area (PricewaterhouseCoopers & IETA 2007b; KPMG 2008; Deloitte 2007). Although these firms had been involved in carbon management consultancy services for some time (see for example PricewaterhouseCoopers, 2007), the IFRIC-3 controversy brought carbon to the attention of more mainstream financial accountants within these firms. This was in keeping with a broader strategic drive on the part of the 'Big Four' to engage in organisational carbon accounting, particularly in relation to carbon disclosure (where, for example, PwC took over the role of compiling annual CDP reports from a small specialist investment research firm, Innovest Strategic Value Advisors, in 2008).

Increasingly since 2005, there is evidence of accountants discursively representing themselves as qualified managers of carbon, and accountancy as 'the natural home' for governing the new low-carbon economy. For example the Association of Chartered Certified Accountants (ACCA) boldly state in their 'Carbon Jigsaw' report that:

> "At some stage in the next 12 months… every major business can expect to be asked about its greenhouse gas emissions and its mitigation strategy…. To respond to such questions and to demonstrate action, businesses will need to involve accountants. *In the future, it will be the role of accountants to represent carbon-related actions in financial accounting terms in the annual reporting process*." (ACCA 2009, p.8; my italics).

Here we can discern three devices at work: first, a broad rhetorical assertion of relevance ("businesses will need to involve accountants"); second, a re-statement of the problem in terms of an existing area of relatively uncontested expertise (financial accounting and annual reporting); and third, a re-affirmation of competence in the redefined arena ("it will be the role of accountants to represent carbon-related actions"). More generally, in this way the problem of climate change is framed primarily as a corporate one, with accountants as central in providing both strategic and practical responses. The Chartered Institute of Management Accountants (CIMA) recently made an even stronger claim in its report *Accounting for climate change: How management accountants can help organisations mitigate and adapt to climate change*:

> "Management accountants have a key role to play in driving sustainable strategic and operational decisions... Failure for management accountants to get involved now, when key decisions are being taken in areas like carbon trading and compliance with new climate change related regulations, could result in far higher costs, lost opportunities or reduced competitiveness." (Chartered Institute of Management Accountants 2010, p.2).

Framing climate change as a corporate problem that can be managed by accountants has a certain allure. It emphasises uncertainty and complexity, and promises a resolution of these difficulties through the application of core accountancy skills. There are certainly echoes here of the application of that characteristic "set of common practices associated with a set of problems to which their professional competence is directed" of an epistemic community (Haas 1992b, p.3). There are also echoes of previously observed tensions between accountants and other professions involved in the production and analysis of non-financial environmental data more generally. In relation to a Chartered Institute of Management Accountants (CIMA) definition of management accounting as encompassing non-financial information, Bartolomeo et al. (2000, p.32) observe:

> "some non-accountants would challenge a definition which can sometimes be perceived as an attempted assertion of professional ownership. This is particularly relevant in environmental accounting and performance measurement, where much of the process of data capture and information generation is, in practice, managed by graduates of natural science disciplines which would themselves claim a long pedigree of measurement expertise."

I turn now to a specific case study that illustrates the interactions between a community of accountancy professionals and a group of NGOs with a common interest in social/environmental disclosure, leading to the creation of a new boundary organisation linking these communities and setting a new standard for combined physical and non-physical organisational carbon accounting: the Climate Disclosure Standards Board.

7.4. Climate Disclosure Standards Board (CDSB) case study

The CDSB was formed at the World Economic Forum in 2007 by a group of influential non-governmental organisations: the Carbon Disclosure Project, Ceres, World Resources Institute, World Economic Forum Global Greenhouse Gas Register, California Climate Action Registry, The Climate Group and the International Emissions Trading Association (World Economic Forum 2007).

It is worth examining these stakeholders in further detail. The **Carbon Disclosure Project** (CDP), which acts as Secretariat to the CDSB, is one of the great success stories of social/environmental carbon accounting. Founded in 2000 by Paul Dickinson, an actuary and entrepreneur, and Tessa Tennant, a pioneering green investment fund manager, the CDP is essentially an environmental pressure group that seeks to influence corporate behaviour by requesting disclosure of carbon (and, more recently) water management accounting

information, on the assumption that measurement will lead to better management. It exerts influence by building and then acting on behalf of a coalition of investors, starting with a group of 35 investors representing US$4.5 trillion in assets in 2002, which had grown to 534 investors representing US$64 trillion in 2010 (Innovest 2003; PricewaterhouseCoopers 2010). In recent years, the CDP has also allied itself with major purchasing organisations such as Walmart, thus exerting supply chain pressure in addition to investor pressure. **Ceres** is a similar US-based counterpart, founded in 1989 and one of the founders (in 1997) of the Global Reporting Initiative (GRI), now the de facto standard for sustainability reporting. Ceres had previously collaborated with CDP, GRI, and other organisations to produce a *Global Framework for Climate Risk Disclosure: A statement of investor expectations for comprehensive corporate disclosure* (Ceres 2006). The **World Resources Institute** describes itself as a "global environmental think tank" and is one of the two founders of the GHG Protocol, now the de facto standard for physical carbon accounting for organisations, recommended as the basis for carbon accounting under both the GRI and CDP (WBCSD & WRI 2004). The now-defunct **World Economic Forum Global Greenhouse Gas Register** was a similar initiative to the CDP, launched in 2003 in partnership with several of the same stakeholders as the CDSB (WRI, IETA and California Climate Action Registry as the operator of the registry) as well as other similar organisations such as the World Business Council on Sustainable Development (WBCSD, the other founder of the GHG Protocol), the Pew Centre for Global Climate Change (another influential environmental think tank), the World Wildlife Fund and – making a solitary appearance in this inter-related set of environmentally-oriented organisations, one of the 'Big Four' accountancy firms – Deloitte. The **California Climate Action Registry** (now transitioned to the Climate Registry) was a similar voluntary carbon accounting and disclosure initiative based in the state of California. **The Climate Group** is another very influential coalition-based environmental pressure group, founded in 2004, and in turn a founder (with IETA, the World Economic Forum and, shortly afterwards, WBCSD) of the Voluntary (now Verified) Carbon Standard, currently the most popular project-level carbon accounting standard in the voluntary carbon offset market (Hamilton et al. 2010). Finally **IETA**, established in 2000, represents key industry players in the market-enabling carbon accounting world, as mentioned in section 7.2 above.[52]

[52] For more information on these organisations see http://www.cdproject.net; http://www.ceres.org/; http://www.globalreporting.org/; http://www.wri.org/; http://www.greenbiz.com/news/2003/12/09/world-economic-forum-creates-global-greenhouse-gas-register; http://www.climateregistry.org/; http://www.theclimategroup.org/; http://www.v-c-s.org/; http://www.ieta.org/ (accessed 10 Dec 2010).

These stakeholders clearly have the characteristics of a small, closely-knit epistemic community. They share values or principled beliefs (which perhaps can be characterised as business-savvy environmentalism); causal beliefs (for example, investor pressure for disclosure will lead to improved measurement which will in turn lead to better management of environmental issues); shared notions of validity (for example, mutual recognition of standards) and a common policy enterprise, seen not least in their support for development of standards and promulgation of these into government policy. To take just one example of the latter, The Climate Group's website proudly lists among its achievements that it "...helped push through California's landmark Assembly Bill 32, making it mandatory for businesses to report and cut greenhouse gas emissions..."[53]

So what was this epistemic community aiming to achieve with the founding of the CDSB? The founding press release states an aim "to establish a generally accepted framework for climate risk-related reporting by corporations. ... CDSB member organizations have agreed to align their core requests for information from companies in order to ensure that they report climate change-related information in a standardized way that facilitates easier comparative analysis by investors, managers and the public." (World Economic Forum 2007).

The members of this social/environmental carbon disclosure community are not, in general, accountancy professionals. Yet they share a common financially informed, business-savvy background, and clearly from the outset saw the involvement of accountancy professionals as instrumental in creating a corporate carbon accounting framework that would be global and mainstream in nature. According to the CDSB Secretariat, close engagement with accountants has been an "absolutely deliberate strategy".[54]

This is reflected in how the CDSB has presented itself and its mission. It is no coincidence that "generally accepted" in the press release quoted above echoes Generally Accepted Accounting Principles or GAAP. Likewise, the CDSB's main output to date has been its Climate Change Reporting Framework, published in September 2010, which has been set out in a format similar to other financial reporting frameworks (CDSB 2010). Its early draft circulated for comments by the CDSB in May 2009 was termed an 'Exposure Draft', again echoing standard practice from accountancy standard setters, and noted that it was

[53] http://www.theclimategroup.org/about-us/achievements/ (accessed 10 Dec 2010).
[54] Interview by Lovell with CDSB core member, July 2009.

deliberately adopting "relevant principles and objectives of financial reporting" in order to provide a "workable filter" through which to view climate change issues (CDSB 2009, p.7).

It is evident that involvement in this standard-setting initiative was welcomed by certain accountancy professionals, as the founding press release relates:

> "'Climate change and the implications on business process and disclosure are finally becoming the topic of discussion that they deserve to be. Ernst & Young and PricewaterhouseCooopers are enthusiastic and supportive participants in this dialogue,' said Paul Ostling, Ernst & Young Global Chief Operating Officer, and Willem Brocker, PricewaterhouseCoopers Global Managing Partner." (World Economic Forum 2007).

This enthusiasm has lasted: accountants have been heavily involved in the subsequent development of the CDSB and its Climate Change Reporting Framework. Structurally, the CDSB comprises a Board, an Advisory Committee and a Technical Working Group. While the Board (which represents the seven original founding partners) and Advisory Committee can be characterised as being largely drawn from the social/environmental carbon disclosure epistemic community (with representatives from business, legal firms, other investor pressure groups, and hybrid governmental-business organisations such as the Carbon Trust and UNEP Finance Initiative), the Technical Working Group comprises mostly accountants (at least 14 out of the 21 core members), including individuals from all the 'Big Four' accountancy firms and five accountancy professional bodies (all ostensibly acting in a personal, rather than representative, capacity). Significantly, it is the Technical Working Group that actually produced the Climate Change Reporting Framework document (CDSB 2010, pp.1–2).

Why have accountants been so eager to be part of this initiative? Part of the answer seems to be that there has been a perceived 'gap in the market' in terms of a professional 'home' for this form of carbon accounting:

> "...with climate change related disclosure being such a new discipline, that hasn't really yet established its own body of professionals, there's a rather fragmented approach within organisations. Does it belong to the procurement department, the premises department, CSR [Corporate Social Responsibility]? You know, it doesn't belong anywhere."[55]

[55] Ibid.

As discussed in section 7.2 above, physical carbon footprinting for organisations was until recently mainly dominated by relatively small, specialised consultancies, lacking almost any common sense of professional identity with which they might counter an extension of claims of competence by the accountancy profession in this area.[56] As the number of firms reporting to CDP has grown, from 235 in 2002 to 3050 in 2010, providing services in this area has undoubtedly become increasingly financially attractive. Additionally, accountants have begun to see at least the *disclosure* aspect as a natural extension of their existing competence:

> "all four [major] accounting firms [Deloitte, PwC, KPMG, Ernst and Young] endorse CDSB's philosophy… and they have all been very active in their participation because it dovetails in with so much work that they are already doing anyway."[57]

There is also some evidence that, as was observed in the case of environmental audit (Power 1991; 1997) accountants are capitalising on their privileged access to management in order to position themselves between management and other 'technical' specialists:

> "I see quite a big distinction between carbon accounting – actually monitoring and reporting and assessing your greenhouse gas emissions and uncertainty levels and all that type of thing... [and] what you make of that [data]. I think the management has to look at that information in the same way that they would financial information and decide what to make of it and reflect their thinking in their management discussions. And we are focusing on the latter rather than the former."[58]

Interestingly, although consciously based on financial reporting principles (and therefore building on accepted accountancy competence and expertise), the Reporting Framework only requires disclosure of physical greenhouse gas emissions and strategic analysis of climate change risks, opportunities and governance (see Figure 13 below). It does not provide guidance on financial reporting of emission rights and liabilities, and in fact the CDSB has only recently become interested in addressing this issue, considering its own development of

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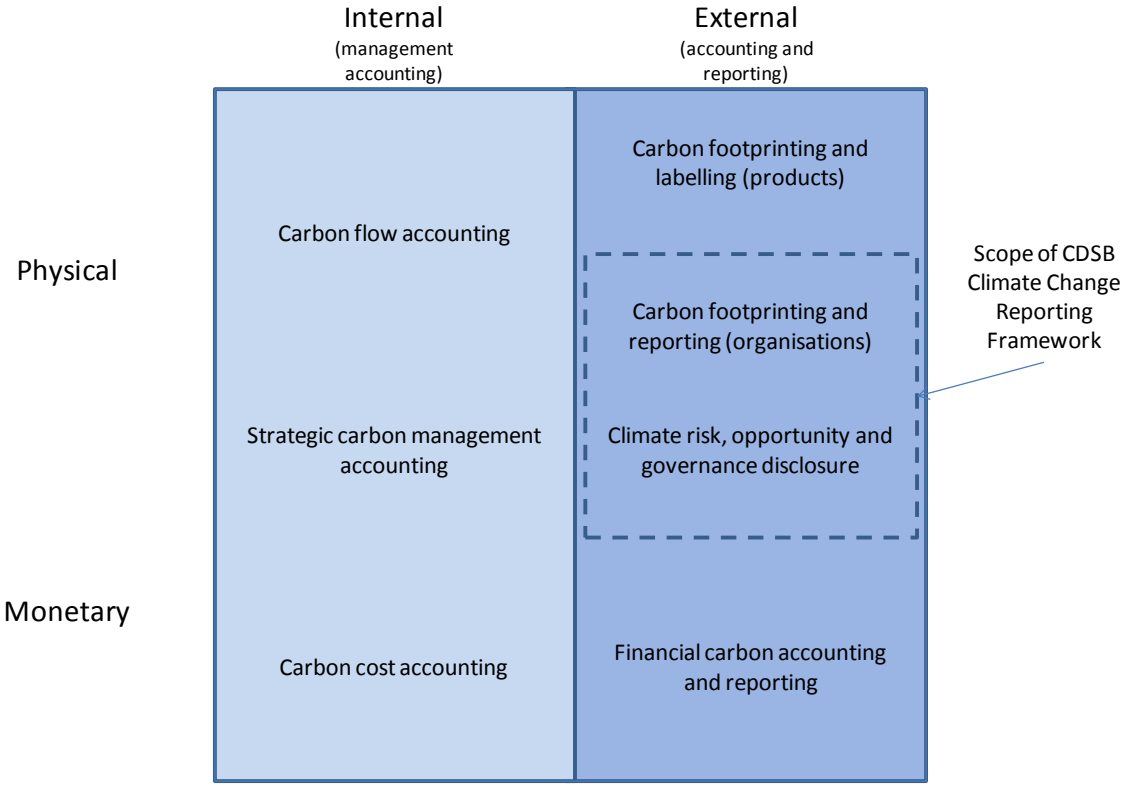
[56] Very recently, a number of professional certification schemes have emerged in the key areas of carbon footprinting (also known as greenhouse gas inventory quantification) and verification, along with a number of new professional bodies, one of which (the GHG Management Institute) is represented on the CDSB Advisory Committee, but not the Technical Working Group. However, clearly this profession is still in its infancy with respect to the accountancy profession. See for example: http://www.csa-america.org/personnel_certification/ghgquantifier_certification/; http://epghg.org/; http://ghginstitute.org/; http://www.carbonprofessional.org/ and http://www.carbonanalyst.org/ (accessed 22 July 2011).

[57] Interview by Lovell with CDSB core member, July 2009.

[58] Ibid.

a separate voluntary reporting standard.[59] It seems, therefore, that even while the accountancy profession is engaged in a strategic expansion of its domain, its internal divisions between financial and management accounting remain difficult to overcome.

Figure 13: A categorisation and examples of key types of carbon accounting at the organisational level



Source: Adapted by the author from Bartolomeo et al. (2000); Burritt et al. (2002; 2011).

Although the accountancy *profession* is now engaging strategically with carbon accounting, I do not believe that this engagement has yet reached the mainstream of rank-and-file accountants. The individuals involved in the CDSB Technical Working Group are a small, close-knit group of technical experts drawn mainly from the four elite global firms, and from accountancy professional bodies which had already established a climate change leadership role (see section 7.3 above). Like the stakeholders on the CDSB Board and Advisory Committee, they too have the shared characteristics of an epistemic community, with the added dimension of all belonging to a clearly defined profession. This accountancy community shares some principled beliefs, such as a genuine concern about climate change, with the social/environmental carbon disclosure community; but their organisation and

[59] CDSB Technical Working Group discussions, November 2011. As of April 2014, however, the CDSB has not produced such a standard, although it has contributed to public consultations on the topic (EFRAG 2013).

interests as a profession, as well as their financial interest in the outcome, sets them apart. Nevertheless, both communities have incentives to work together, with the social/environmental carbon disclosure community being apparently very willing to invite the accountants into their domain, in return for the benefits of mainstreaming carbon disclosure into corporate financial reporting. In summary, the CDSB appears to be a classic boundary organisation, drawing its membership from two separate epistemic communities and enabling each to extend their influence on organisational carbon accounting.

7.5. Summary

In this chapter I have drawn attention to the politics of carbon accounting at the level of communities: who defines it, who claims to have competence in it, and how such claims are justified and reinforced. I have shown that multiple communities are involved in carbon accounting, each framing it in their own discourse, with their own standards, techniques and practices. I then focus on organisational carbon accounting, which can be further sub-divided into physical and non-physical (monetary and strategic) dimensions, as well as according to whether it is produced for internal or external accounting and reporting purposes, as summarised in Figure 13 above.

Accountants have been involved in setting standards for physical, external organisational carbon accounting since at least 2001, but as only one of several different communities active in this field, and against a backdrop of initial reluctance and lack of awareness from rank-and-file members of the profession. Financial reporting of emission rights surfaced as a significant issue for large companies in the run-up to the 2005 start of the EU ETS, and highlighted an area of carbon accounting where accountants could indisputably claim competence. This occurred at roughly the same time as a broader strategic push by the accountancy profession into other forms of organisational carbon accounting, particularly the external disclosure and management interpretation of physical and strategic carbon-related information. Competence is also being claimed in virtually all aspects of internal carbon management accounting (Chartered Institute of Management Accountants 2010) although the evidence to date suggests that accountants are not yet actively involved (Burritt et al. 2011).

The broader participation of accountants in carbon accounting has many positive aspects, and I hope to have shown that the interaction between the accountancy profession and the social/environmental disclosure community in forming the Carbon Disclosure Standards

Board and producing the first Climate Change Reporting Framework has been productive, and beneficial for both sides. However, I believe that this initiative should not go un-scrutinised. The involvement of accountants and efforts to align the Climate Change Reporting Framework with financial reporting standards has led to the use of technical terminology and cross-referencing to other financial accounting concepts and documents which may serve as a barrier to non-accountants, both in terms of those who would provide carbon accounting services and in terms of the 'lay' user of such information. It is worth remembering that incorporating carbon accounting information in company financial reports is not the only way such information might be collated or presented: there are many other options, including radical alternatives such as the 'open-access' model pioneered by the environmental pressure group Sandbag, which presents site-specific emissions, allocations and offsets data derived from the EU ETS registry in an online map-based format – an example of counter-reporting (Gallhofer et al. 2006).[60]

[60] See http://www.sandbag.org.uk/ (accessed 10 December 2010).

8. Making things different: the case of UK forest carbon

8.1. Introduction

Carbon markets, offsetting and carbon management all fundamentally depend on carbon accounting 'making things the same' (Mackenzie, 2009). In other words, a key function of carbon accounting is commensuration (Espeland & Stevens 1998; Levin & Espeland 2002). Commensuration brings together things that are fundamentally different with respect to various properties as well as separate in time and space, like the destruction of industrial waste gases in China on the one hand, and carbon dioxide emissions from a combined heat and power plant in the UK on the other, mentioned in chapter 3.3 (Mackenzie, 2009). It equates physical objects (such as emissions and removals) with intangible concepts (such as emission rights, allowances, credits and offsets). It re-states diverse things in common currencies, such as tonnes of carbon dioxide equivalent, or money pure and simple, enabling transactions, comparing alternatives, and evaluating performance. Ultimately, commensuration re-fashions the world – physically and cognitively.

However, commensuration doesn't always work. The same kinds of process that bring disparate things together – such as quantification, measurement and the creation of standards – can also unexpectedly achieve the opposite, making previously identical things *no longer the same* in ways that matter, with material consequences, such as affecting the ability of something to attract investment. As this chapter will explain, this has been the case with forest carbon in the UK. This case study provides both a detailed examination of commensuration in action, and an analysis of how and why it fails, leading (in certain cases such as this) to fragmentation and difference. I will argue that the case makes a contribution to the theory of commensuration in two ways: first, by highlighting a uniquely *moral* dimension to commensuration not explicitly recognised in the previous model put forward by Levin & Espeland (2002); and second, by using the concept of framing to help explain how things can be made different as a result of overlaps or conflicts between different frames of commensuration, or different world-views about what can or should be considered the same. At times, conflict between different frames can take the form of overt and explicit controversies (for example, I will discuss deliberate NGO action against carbon offsetting and forest carbon), but equally, the case provides evidence from the UK of conflicts between frames which are less indicative of political opposition but rather an unintended consequence of the proliferation of carbon management objectives, multiple levels of governance

involving both state and non-state actors, and the resulting complexity of carbon accounting practices.

As with any case study, the lessons from this case may not necessarily apply to a broader set of circumstances. However, there is ample evidence of increasing fragmentation and differentiation in carbon markets globally. In 2013, the World Bank signalled this when it changed the name of its annual 'State and Trends of the Carbon Market' report (published under that name in an unbroken series since 2003) to 'Mapping Carbon Pricing Initiatives', acknowledging that "Regional, national and sub-national carbon pricing initiatives are proliferating" and providing a table of 21 different approaches to carbon pricing, delivering prices ranging from US$0.85 to US$163 per tCO_2e (Kossoy et al. 2013, pp.11, 81–82). The original idea of 'the' global, unified carbon market no longer exists. While the political drivers and practical implications of this fragmentation are widely discussed, the underlying processes have not yet been examined from a social science perspective. I therefore believe that this case study draws attention to, and helps make sense of, an important and hitherto overlooked social process, of current relevance to carbon accounting but which could also be helpful in understanding commensuration and its opposite – making things different – more generally.

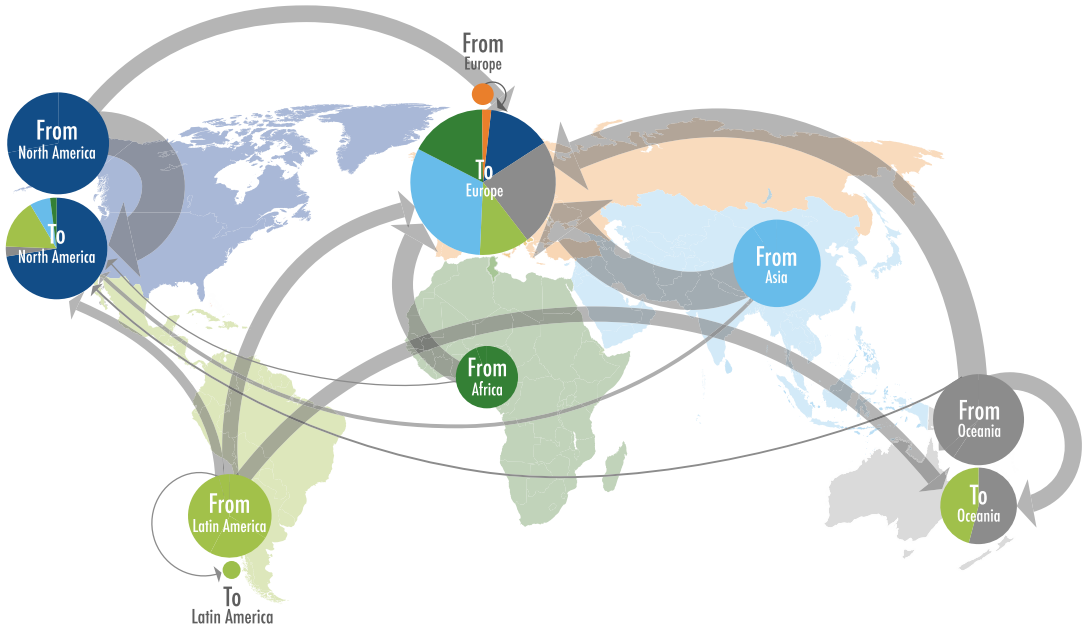
8.2. Controversies in accounting for UK forest carbon

Investors in UK forests feel frustrated. Although UK forests draw down and store carbon from the atmosphere just as they do anywhere else in the world, their owners struggle to obtain value from this service. Yet when they look abroad, they can see that in 2012 alone, 1.2 million hectares of new forest, representing 8.6 $MtCO_2e$ of enhanced removals, attracted a total of US$61 million in carbon market transactions (Peters-Stanley et al. 2013, pp.19, 25).[61] Forest owners in countries as diverse as China, Australia, New Zealand, Nepal, Uganda, the USA and Canada have all shared in this flow of carbon finance (see Figure 14 below). Nevertheless, only a few UK forest owners manage to obtain any benefit from sequestering carbon, despite the fact that UK businesses account for a significant proportion of total demand in forest carbon markets (European buyers, mainly UK, French and German companies, bought more than half of all forest carbon offsets in 2012 – Peters-Stanley et al.

[61] Note that 'transactions' adds together all financial transfers along the carbon value chain, and includes both up-front payments, contracts for future payment on delivery, and secondary transactions (selling an issued credit to someone else). Therefore the amount actually going to forest owners is uncertain, but at least US$38 million in up-front payments represents a direct transfer, with a further US$7 million promised on delivery of the carbon offsets (Peters-Stanley et al. 2013, p.19).

[2013, p.44]), and many would prefer to buy locally-sourced credits.[62] They are prevented from doing so by a variety of different carbon accounting rules that block access to certain markets or prohibit recognition of UK forest carbon offsets under specific standards, highlighting fundamental differences in the framing of UK forest carbon, that in turn undermine its commensuration with otherwise identical forest carbon in many other countries. The case study highlights the way in which the idea of a carbon credit or offset is socially constructed, and the role of discourse, standards and communities in shaping accounts of UK forest carbon.

Figure 14: Flows of forest carbon transaction value, 2012



Source: Peters-Stanley et al. (2013, p.44).

8.2.1.A struggle for legitimacy – UK forest carbon and offsetting, 1997-2006

As related in chapter 5, the concept of planting trees to compensate for emissions elsewhere lies at the origin of the practice of carbon offsetting, dating back to the AES investment in agroforestry and woodlot plantations in Guatemala in 1989. Voluntary carbon offsetting later developed into a more widespread 'retail' phase in which forest carbon also featured heavily: one of the first major retailers of voluntary carbon offsets in the UK, established in 1997 and now known as The CarbonNeutral Company, was originally called Future Forests because planting trees was its primary offsetting strategy. Its first client (thanks to its founders'

[62] Based on anecdotal evidence from multiple buyers, cited by a UK forest carbon project developer, pers. comm., 14 January 2014.

connections with the entertainment industry) was the Rolling Stones, followed by other bands and celebrities such as Coldplay, Brad Pitt and Leonardo DiCaprio, and high-street names such as Sainsbury's, BP and Barclays (SinksWatch et al. 2004; Chittenden 2006; Smith 2007). Some of these early offsetters bought the 'rights' to claim the carbon sequestered in UK forests: for example, Rolling Stones guitarist Ronnie Wood had "a wood of his own in Scotland", as did singer KT Tunstall (3,500 trees near Peebles), David Gray (10,000 trees in the Midlands) and the Sex Pistols (500 trees in Essex) (Chittenden 2006). Other Future Forest projects were based in developing countries.

An examination of 1,818 English-language media articles using the term "carbon offset" up to mid-2007 shows that this popularised 'retail' phase of carbon offsetting, which started in the UK around 1997, enjoyed near-uniform positive publicity for many years.[63] However, in 2002, some UK tree-planting charities started to complain about the low prices they were being paid by Future Forests (e.g. 12p/tree), compared to the actual costs of planting and maintaining a tree for 100 years (e.g. £15/tree):

> "It is one of the most fashionable environmental campaigns of the moment. Backed by pop and rock stars from Pink Floyd to Atomic Kitten, Future Forests finally won national recognition this year when it was selected as the chosen cause of the 2002 Brit Awards. … Set up five years ago, the organisation does not actually plant trees: it signs contracts with tree-planters. Some are now complaining of the 'tiny' payments offered." (Blake & Summerskill 2002).

A more serious backlash against forest carbon offsets emerged in 2004, when a concerted campaign by seven environmental NGOs (SinksWatch et al. 2004) led to headlines such as "Celebrity tree-planting schemes a 'phoney fix' for global warming" (Edwards 2004). The NGOs targeted the two leading UK-based offset retailers, Future Forests and Climate Care, sending letters to 200 of their clients and press releases to the media (SinksWatch et al. 2004). At the same time, they lodged complaints with the British Advertising Standards Authority disputing the 'carbon neutral' claims made by these two companies via advertisements for Tower Records, Barclays and The Phone Co-Op (SinksWatch et al. 2004; Smith 2007). The complaints rested on the requirement in the British Code of Advertising that any "significant division of scientific opinion" is reflected in claims made by an

[63] Search undertaken by the author using the 'News' section of LexisLibrary http://www.lexisnexis.com (accessed 8 January 2014). Resulted in 1,818 items up to 31 May 2007.

advertisement, and centred on the scientific controversies surrounding forest carbon sinks in particular (Smith 2007, p.15).

The NGOs fundamentally objected to the commensuration (in the negative) of fossil fuel emissions, on the one hand, and the emission reductions or enhanced removals that carbon offsets claim to represent. They appealed to the scientific framing of carbon accounting for support:

> "Pretending that a tonne of carbon stored in trees is the same as a tonne of fossil carbon ignores the very basics of the natural carbon cycle. There is enormous scientific controversy about how much carbon dioxide any given tree-planting can take out of the air, and for how long." (SinksWatch et al. 2004, p.2).

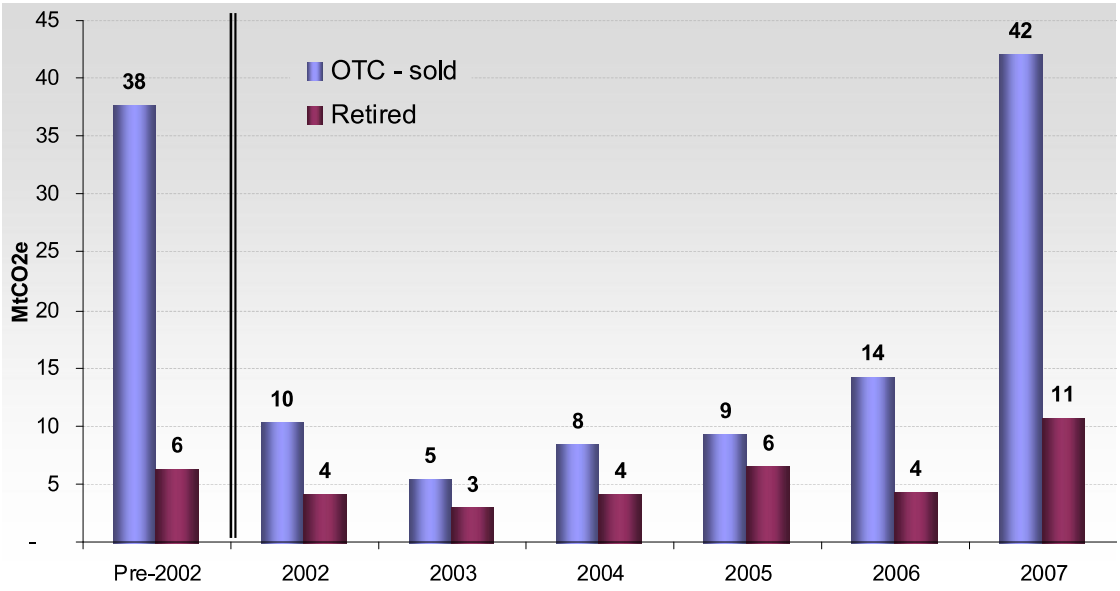
The SinksWatch et al. (2004) press release contains a formidable list of over 30 publications, mainly from scientific peer-reviewed journals, that it claims provide "an indication of the controversies surrounding the possibility of calculating the capacity of tree-planting and other forestry projects to 'offset' carbon emissions" (SinksWatch et al. 2004, p.4). The broad thrust of the argument is that carbon stored in forests is qualitatively different to carbon stored in fossil fuels, because the latter is 'inert' whereas the other is 'active' (Smith 2007, p.19) – in other words, capable of returning to the atmosphere over relatively short time-scales. They also point to the many scientific challenges associated with measuring carbon stored in forests (as discussed in chapter 5) and with projecting credible baselines, not only for forestry projects but energy efficiency and renewable energy activities as well.

Later in 2004, the tree-planting charity Trees for Cities revived its earlier complaint about the low prices being paid by Future Forests to UK forest owners, as opposed to actual tree-planting costs, lodging a formal complaint to trading standards officers at Camden council in north London, where Future Forests was registered at the time (Muir 2004). Media criticism of offsetting mounted in 2006, in step with rapidly increasing growth in the voluntary carbon market (see Figure 15 below). Celebrity endorsement became a vulnerability: in April 2006, the *Sunday Telegraph* reported that 40% of the mango trees supposedly offsetting the band Coldplay's 2002 album had subsequently died (House of Commons Environmental Audit Committee 2007, p.59). As the number of offsetting firms proliferated, observers began to notice that the figures provided in different online carbon calculators varied considerably, both in terms of the estimated emissions and the offsetting cost:

> "Climate Care says that a flight from London Heathrow to Sydney and back generates 5.61 tonnes of carbon dioxide, which will cost £42.11. The CarbonNeutral Company calculates it at 3.7 tonnes, which you can offset by planting trees for £27.38. A third company, Grow a Forest, agrees with 3.7 tonnes, but asks £46.15 for its trees to offset it. Such variations do little to inspire public trust." (Robbins 2006)

Finally, several NGO reports were published in 2006 which started to compare offset retailers and the standards (up until that year, mainly proprietary to each company) that they were using (Trexler Climate + Energy Services 2006; Kollmuss & Bowell 2006).

Figure 15: Volumes transacted and retired in the 'over-the-counter' voluntary carbon market, pre-2002 to 2007



Source: Hamilton et al. (2008, p.27). Data is expressed as 'over-the-counter' (OTC) in order to exclude transactions under the Chicago Climate Exchange (CCX), a voluntary cap-and-trade scheme.

In addition to technical concerns, the NGO objection to offsetting incorporated a fundamentally moral dimension, encapsulated in this statement from SinksWatch coordinator Jutta Kill:

> "What companies like Future Forests promise their customers is the *absolution of their carbon sins*… They can keep burning as much fossil fuels as they like in exchange for planting a few trees. The idea is a phoney climate fix, and a dangerous illusion" (Edwards 2004; my italics).

In a similar vein, Smith (2007) describes offsets as "indulgences for your carbon sins", likening offset retailers to medieval pardoners, who sold a notional surplus of an

ecclesiastical good, repentance, as "indulgences to sinners who had money, but not necessarily the time or inclination to repent for themselves", thus providing the Catholic Church with much-needed income generation (p.5). The idea is taken even further by the website cheatneutral.com, which (as a joke, explicitly to satirise carbon offsetting) provides a service for those who have cheated on their partners to offset this by paying other couples to remain faithful.[64] Such analogies abound in the literature criticising carbon offsetting: "It's like giving money to the RSPCA so you can keep kicking your dog." (Robbins 2006). Alan Simpson MP (Labour) said this during Parliamentary debate on the UK Climate Change Bill:

> "If a Member of Parliament were stopped by the police and found to be driving three times over the alcohol limit, they could not give the excuse that although they might be blind drunk at the wheel, they had sponsored a man in Botswana to stay at home sober. That would not get them off the rack. *We have to be held to account* for the dangers that we present in how we drive our economy, as we are when we drive our cars. We are the danger on the road to survival and we have to change our behaviour ourselves." (Hansard 2008; my italics).

Taken at face value, these analogies all seem fundamentally flawed, for the simple reason that cheating, kicking your dog or driving three times over the alcohol limit all have individual *local* impacts, rather than only having significance at a cumulative, global level. Carbon offsetting is predicated on the fact that carbon emissions *have no local impact*. But this is not the point – what is so interesting about these analogies is the fact that they are made at all, and their evident discursive power. It seems that successful commensuration – at least in the case of carbon offsetting, equating emission reductions or removals, in the negative, with actual emissions elsewhere – requires a degree of moral acceptance, in addition to a vast array of more technical measurement-related procedures (what Levin & Espeland [2002, p.132] call 'technical commensuration').

Skopek (2010) proposes that there are three different types of moral objection to offsetting (and carbon or environmental markets in general), based on different ethics. The first, based on a deontological or rule-based view of ethics, focuses on the implicit or explicit 'right to pollute' conveyed by a carbon offset or credit, arguing that "polluting is itself morally objectionable, and as such is a type of act — like cruelty or racial discrimination — that one should not be able to buy the right to do." (p.2068). The second, from a consequentialist perspective, argues that the commodification of carbon will make people less likely to

[64] See http://cheatneutral.com/ (accessed 9 January 2014).

protect the environment, because it "undermines the current social sanction that attaches to excessive emissions, thereby transforming pollution from a social evil into a neutral commodity." (Strahilevitz 2000, p.1232; quoted in Skopek 2010, pp.2068–9). The third objection is based on virtue ethics or the idea that:

> "…it is not an action's consequences or adherence to a rule that makes it good. Rather, what is important is the character of the actor. And good character is manifest not only in specific actions, but also in reasons for action and modes of relation to the objects of action." (Skopek 2010, p.2071).

According to this view, the act of commensuration that underpins offsetting "dissolves the qualitative distinctions between types of carbon emissions that underlie evaluations of virtuous character." (p.2075). Essentially, the argument here is that carbon emissions are incommensurable, and that human virtue is lost when they are forcibly commensurated.

In summary, NGO objections to offsetting, at this particular point in time, were based on a complex combination of factors, along a spectrum ranging from the purely technical to the purely moral, including:

1. Concerns about technical commensuration (e.g. carbon stored in forests is qualitatively different to fossil carbon, it is potentially reversible, measurement is uncertain);
2. Concerns about ex-ante crediting of future removals and a mismatch with present emissions (originally, forest offsets were sold at the time of planting a tree, on the basis of the carbon it was calculated to absorb in future);
3. Concerns about baselines (how to measure emission reductions or enhanced removals against what would have happened otherwise) and lack of standards, insufficient stringency of standards, or lack of enforcement of standards;
4. The fact that offsetting does not necessarily lead to net reductions (as reductions in one place allow increases in emissions elsewhere);
5. The possibility that offsetting could actually encourage higher net emissions, either by providing a marketing advantage for otherwise environmentally damaging goods ('greenwash') or distracting attention from more fundamental changes required to shift to a low-carbon economy;
6. Concerns that offset retailers exploit and profit from the providers of the carbon offsets by under-paying, taking away their rights and/or privatising public goods;

7. Concerns that variations in estimates of emissions and costs of offsets imply a lack of rigour and/or excess profit-taking from consumers of the offsets; and
8. Fundamental moral objections (deontological, consequentialist and virtue-based) to offsetting, which would apply even if the above concerns were all satisfied.

Forest carbon acted as a lightning rod for NGO objections to offsetting more generally. There are three plausible reasons for why forest carbon was particularly exposed to criticism, over and above objections to offsetting in general. First, at a symbolic level, trees are emblematic of the environment: this both constituted an important part of their appeal to carbon offset retailers, and created a source of tension with environmental NGOs who felt they had a prior, and more genuine, connection with the tree as a symbol, as well as with what it represents. "Trees are a huge icon people can relate to" said a spokesperson for Future Forests, quoted by Muir (2004), while Smith observes:

> "Trees are strongly symbolic of green politics, with many environmental groups like the US-based Sierra Club using trees in their logos. …To call somebody a 'tree-hugger' is to describe them as being ecologically-sensitive. The idea of planting trees in order to 'neutralise' emissions taps into a pre-existing cultural notion that something with obvious environmental benefits could be used to cancel out doing something environmentally damaging. *But it just doesn't add up*." (Smith 2007, p.19; my italics).

Second, forest carbon offsetting also attracts more controversy than most other types of offset project, such as renewable energy or energy efficiency, because of the high uncertainty associated with many technical aspects of its commensuration with emissions. The carbon stored in forests – anything beyond a few trees dug up and 'destructively sampled' – can never be directly measured, but must always be estimated using complex methods that rely heavily on esoteric scientific expertise and which involve many assumptions, the effects of which are frequently compounded. The complexity of forest carbon accounting even confounds the most 'expert' of scientists, as illustrated in this quotation from IPCC Chair Bob Watson in 2001:

> ''Yes it is complex. And I've often myself, when I've been flying in an aircraft, and I've flown over complex landscapes, and... how the hell can you measure carbon down there to a few per cent? The people that measure the carbon, either by satellite measurements or by flux towers, or by, sort of, sort of looking at the forest... all claim that within some reasonable degree of accuracy or precision you can do it. But when I look down on a complex landscape, I have to be honest, its... um... I get very impressed if these guys

> are indeed correct. But, hey, the fact that when I look down in an aircraft and I think its going to be complicated, that's my gut instinct versus the scientific community's. And they claim they can demonstrate what precision and accuracy they can get… One has to go with what these scientists are saying." (Fogel 2005, p.206).

Third, carbon offsetting at the popular, retail level of the voluntary carbon market became embroiled in the politics of carbon accounting and offsetting at the national and international level, under the Kyoto Protocol, with ramifications that were damaging for any form of 'domestic' offsetting in the UK, and forestry in particular. Smith (2007, p.17) observes: "In some ways, the criticism that forestry offset credits have received mirrors the move away from using forests and tree-plantations as 'carbon sinks' under the Kyoto Protocol." Russia's ratification of the Kyoto Protocol in September 2004, which enabled the treaty finally to come into force in February 2005, brought national targets and accounting into greater focus than before. This created a new problem for UK forest owners: the carbon they considered as 'theirs' was also being accounted and thereby 'claimed' by the state. I will return to this in section 8.2.3, which explains how forest carbon is viewed from the UK Government perspective.

8.2.2. The industry response: discourse, standards, infrastructure and alliances

The offsetting industry did not cave in to this NGO pressure and stop selling offsets. It resisted, issuing its own press releases and rebuttals (e.g. see Edwards [2004]), and taking other actions that can be interpreted as discursive attempts to control the terms of the debate. Other key elements of the industry's legitimation strategy involved the creation of standards and related infrastructure such as registries, and setting up alliances and representative bodies, together comprising a complex apparatus of voluntary self-regulation aimed at strengthening the claimed commensuration of emissions and offsets. I will focus here on the company Future Forests, which has played a leadership role in the offsetting industry, while acknowledging that other companies (notably Climate Care, in the UK) were also deeply involved in the industry's overall legitimation strategy (see Lovell et al. 2009).

Future Forests had already trademarked the term 'CarbonNeutral' in 1998.[65] This proved to be a savvy move, as the term 'carbon neutral' became extremely popular, to the point of being recognised as 'Word of the Year' by the New Oxford American Dictionary in 2006 (Safire 2008). In September 2005, Future Forests changed its name to The CarbonNeutral

[65] See http://www.carbonneutral.com/about-us/our-history (accessed 9 January 2014).

Company (TCNC), overtly because it had diversified away from forests into other categories of carbon offset, such as energy efficiency and renewable energy, but conveniently also deflecting the negative publicity that had come to be associated with both the 'future' (implying ex-ante crediting of future removals) and the 'forests' parts of its original name (Smith 2007).

In 2003, TCNC developed the first version of its CarbonNeutral Protocol, a company-specific (proprietary) standard, setting out its requirements in order to allow entities to make a claim of carbon neutrality using TCNC's trademarked 'CarbonNeutral' terminology. The Protocol covers (at a very high level) how to measure an entity's emissions, setting targets to reduce emissions, offsetting and communication of the CarbonNeutral claim. The CarbonNeutral Protocol has been revised many times since then and is still in use by TCNC (The CarbonNeutral Company 2013). In 2007, the Protocol was supplemented with a Policy for Accounting and Reporting Carbon (PARC), developed together with PwC and claiming to be "based on established financial reporting standards… to ensure that reports on carbon trading are understandable, relevant and allow fair comparisons with previous reporting periods" (BusinessGreen 2007). This carbon accounting standard never achieved wider recognition and is no longer available on TCNC's website. Also in 2007, the company established a public register of its offset projects. This has now been superseded by the existence of multiple registries provided by third parties, such as Markit and APX (Peters-Stanley & Yin 2013).

In 2005, TCNC set up an Advisory Forum, with members drawn from business, academic and NGO circles. It also drew on the scientific advisory services of the Edinburgh Centre for Carbon Management (ECCM), set up by another carbon accounting pioneer, Richard Tipper, in 1993.[66] Smith (2007, p.17) notes that "The company has gained further legitimacy by acting as the secretariat in the All Party Parliamentary Climate Change Group, which works 'closely with businesses in order to develop policy options that will work to more fully integrate government and business in tackling climate change.'" Finally, TCNC together with various other offset retailers in 2008 set up the International Carbon Reduction and

[66] ECCM was acquired by the offset project developer Camco in 2007, and then sold as part of Camco Advisory Services to Baxi Partnership in 2012, where it is now known as Verco. See http://www.vercoglobal.com/sustainability-services/carbon-accounting-and-reporting (accessed 10 January 2014). Tipper also established another carbon accounting standard, Plan Vivo, in 1994 and set up a carbon accounting and reporting company, Ecometrica, in 2008.

Offset Alliance (ICROA), with the aim to "promote best practices in carbon management and offsetting".[67]

By 2006-2007, numerous 'industry-wide' standards were being developed. Hamilton et al. (2007, p.8) observe that:

> "In 2006 and early 2007, the issue of quality in the voluntary market became very visible in the form of media stories and articles questioning the validity of offsets being sold. This backlash was (at least partly) the result of the increased growth and visibility of the market, but it also helped to fuel increasing efforts on the part of those interested in the industry to strengthen quality and create standards."

The early standards (Hamilton et al. 2007) included Plan Vivo (established in 1994 but not formalised as a standard until 2008, restricted to community-scale agro-forestry projects); the WRI/WBCSD GHG Protocol for Project Accounting (WBCSD & WRI 2005); ISO140064 Part 2 (Project Accounting) (ISO 2006b); the Gold Standard (established by WWF and other environmental NGOs in 2003, with its first voluntary offsetting standard issued in 2006); the Voluntary Carbon Standard (VCS, established by The Climate Group, International Emissions Trading Association and World Economic Forum, version 1 first issued for consultation 2006, first formal standard issued 2007); Greenhouse Friendly (an Australian Government initiative which operated from 2001 to 2010)[68]; the Chicago Climate Exchange (CCX) Offsets Program (started 2003); the California Climate Action Registry (CCAR, established 2001) and Social Carbon (established in 2000, first published as a standard in 2008). 2007 was characterised as "Year of the Standard" (Hamilton et al. 2008, pp.9, 48):

> "The role and rise of third party standards is considered by many market players to be THE major trend of 2007. Suppliers embraced the idea of standards as a means of proving their legitimacy, and buyers increasingly asked for certified credits as one means of avoiding 'fool's gold.'" (Hamilton et al. 2008, p.52).

Today, the voluntary carbon market is dominated by the VCS (which changed its name to the Verified Carbon Standard in 2011) with 55% market share, the Gold Standard (13%),

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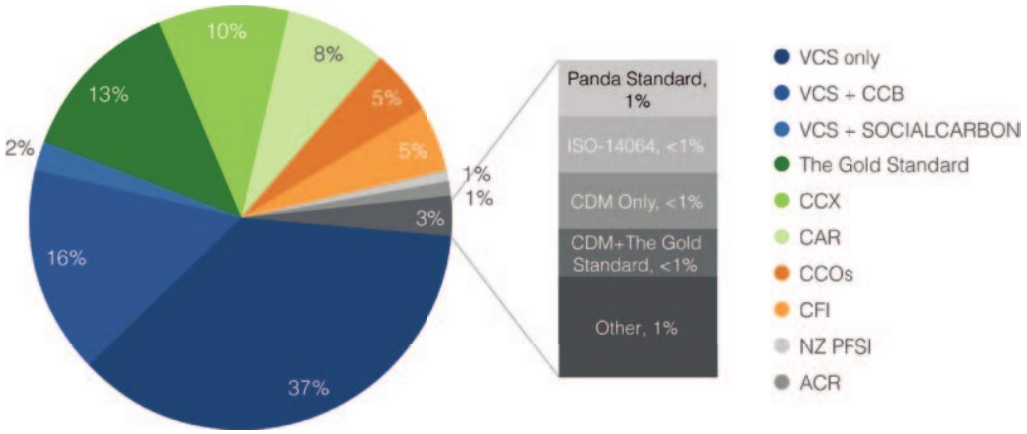
[67] See http://www.icroa.org/25/about-us/ (accessed 10 January 2014).

[68] See http://www.climatechange.gov.au/climate-change/carbon-neutral/national-carbon-offset-standard-ncos/greenhouse-friendly (accessed 17 February 2014).

CCX (10%) and the Climate Action Reserve (CAR, successor to CCAR) with 8% market share, as shown in Figure 16 below.

Figure 16: Voluntary carbon market share by project standard, 2012



Source: Peters-Stanley & Yin (2013, p.xi).

The VCS is a 'universal' standard that can be used for carbon offsets in any sector and in any country, subject to approval by the scheme of a suitable carbon accounting methodology for each project type. It has a particularly well-developed set of rules for agriculture, forestry and other land use (AFOLU) projects, which has helped it to capture 57% of the total forest carbon market (Peters-Stanley et al. 2013, p.45). Meanwhile, the Gold Standard, which was originally limited to renewable energy and energy efficiency projects, purchased CarbonFix, a small forestry-specific offset standard, in September 2012, and signed an agreement with the Forest Stewardship Council (FSC) and the Fairtrade consumer label, providing a foundation for expansion into the forest sector. This move was motivated by on-going NGO concerns about offsetting in the forest sector:

> "'This is not about doing land use for land use's sake,' [said Gold Standard CEO Adrian Rimmer]… 'We've had a lot of pressure from the NGO community, to say "we're really concerned about the growth of land use in the carbon market" ... about the level of rigour around not only the carbon accounting, but the other claims [attached to the projects].'" (Kouchakji 2012).

As universal standards, the VCS and Gold Standard recognise the potential for overlap with other carbon accounting programmes. In order to ensure the integrity of their own carbon credits, both standards contain provisions against double-counting of GHG emission reductions (or removals). Requirement 3.11.6 of the VCS Standard states, "Project

proponents shall not claim credit for the same GHG emission reduction or removal under the VCS Program and another GHG program." (Verified Carbon Standard Association 2013, p.19). Requirement 3.11.2 provides guidance for emission reductions or removals which take place within the scope of an emissions trading mechanism, specifying that they may only be recognised under the VCS if evidence is provided showing that "the GHG emission reductions or removals generated by the project have not and will not be otherwise counted or used under the program or mechanism." (Verified Carbon Standard Association 2013, p.18). Such evidence may include, inter alia, (1) a letter from a national authority stating that an equivalent number of allowances or other credits have been cancelled from the programme or national cap; (2) evidence of voluntary purchase and cancellation of an equivalent number of allowances; or (3) evidence that the emission reductions or removals in question fall outside the scope of the scheme.

The Gold Standard contains a similar provision (with respect to energy projects) at Requirement III.b.3: "where host countries or states have caps on GHG emissions, projects shall only be eligible if the Project Representatives have provided the Gold Standard Foundation with satisfactory assurances that an equivalent amount of allowances are retired to back-up the GS VERs issued. Any AAUs may be retired for this purpose." (The Gold Standard Foundation 2012, p.23). The current 'road-test' version of the Gold Standard Requirements for Afforestation/Reforestation indicates that more specific guidelines on double-counting for AR activities are under development (The Gold Standard Foundation 2013, p.3).

These double-counting provisions are highly problematic for UK forestry projects, because the UK has legally binding caps on its emissions under both the Kyoto Protocol and the UK Climate Change Act 2008. The UK accounts for afforestation/reforestation and forest management under the Kyoto Protocol, and for LULUCF comprehensively under the Climate Change Act 2008 (HM Government 2008), so there is no possibility of avoiding double-counting by developing projects outside the scope of these schemes (option 3 under the VCS). Option 1 (which involves the national authority cancelling an equal number of units from the national cap) might seem to be reasonable, because every tonne of CO_2-equivalent sequestered by a forestry project, if the project is truly additional (i.e. beyond business as usual) and above the minimum size captured in the national forest carbon accounting system, effectively allows the UK to emit a tonne of CO_2-equivalent somewhere else in the economy, while staying within the constraints of the its Kyoto Protocol and

Climate Change Act targets (see Annex 1 for a detailed explanation of how this accounting works). Therefore if the UK cancelled an equivalent number of units from its own account, it would only be returning to the situation it was in without the (additional) project. To put this another way, if the project is truly additional, then – absent a procedure to cancel units from the national account and thus enable the forest owner to claim a carbon credit for themselves – the Government obtains the benefit despite the fact that the project would not have happened without some kind of intervention by the forest owner or project developer. This is precisely the current situation, as the UK Government has no procedures in place to cancel allowances or other credits in recognition of this benefit. In the next section, I will explore why the UK Government has been unwilling to set up such a procedure – it is technically feasible but has not been implemented due to the way the UK Government has historically viewed voluntary carbon offsetting, forest carbon and 'domestic' projects – in other words, its framing of the issue. This leaves UK forest owners with just one option, if they wish to use these international standards: for every carbon credit they wish to claim, they must themselves purchase and cancel an existing allowance or other credit (VCS option 2), which clearly adds to the cost of generating a carbon credit and effectively prices them out of the market. Consequently, there have been no VCS projects (whether forestry or any other kind) in the UK since 1 January 2008, when the Kyoto Protocol targets came into effect.[69]

In summary, from 2004 onwards, the 'retail' offsetting industry responded to attack by environmental NGOs and the media by changing key terms of the debate and strengthening the technical apparatus of commensuration through the development and promotion of standards, registries, alliances and representative bodies. One consequence was a shift away from forestry, particularly UK forestry, due to the issues previously discussed which made it the early target of NGO criticism. By 2006, forests accounted for only 20% of TCNC's portfolio (Trexler Climate + Energy Services 2006, p.17) and globally, forestry projects, which dominated the voluntary carbon market until 2004, fell to 36% market share by 2006 and a low of just 11% in 2008 (Hamilton et al. 2008, p.37; Hamilton et al. 2010, p.34). The voluntary market as a whole, however, grew vigorously in these years, as shown in Figure 16 above – in spite of the NGO and media backlash.

[69] There has only been one VCS project in the UK – project ID 216 involving utilization of coal mine methane at Mansfield Colliery, which received credits up to 31 December 2007. See http://www.vcsprojectdatabase.org/ (accessed 14 April 2013).

Since 2009, forest carbon has made a comeback in the international voluntary carbon market, returning to 24% market share in that year, thanks to "an emerging consensus around forest carbon project protocols and procedures, as well as mounting political recognition of the importance of forests in halting rapid deforestation and deploying carbon finance to developing nations." (Hamilton et al. 2010, p.34). However, this has only benefited forests in developing countries and a few select developed countries, such as the USA, Australia and New Zealand. The very apparatus of commensuration that has spurred investment in forest carbon internationally – wider acceptance of offsetting standards – effectively makes UK forest carbon *different*, and hence less attractive to investors, due to these standards' prohibitions on double-counting, in the context of the UK's Kyoto Protocol and Climate Change Act targets, and the absence of a procedure to cancel suitable units in recognition of the benefits of forest carbon projects. The next sub-section relates how a coalition of forest industry stakeholders working with a sympathetic government agency (the Forestry Commission) has attempted to negotiate a compromise solution, against a backdrop of resistance from other key government departments.

8.2.3.The Woodland Carbon Code: A comeback for UK forest carbon?

In 2009, an independent assessment of the potential of the UK's forests to help with mitigation and adaptation to climate change was commissioned by the Forestry Commission. The report highlighted a "clear need for more woodlands" (Read et al. 2009, p.ix), arguing that "woodlands planted since 1990, coupled to an enhanced woodland creation programme involving planting 23,200 ha… of forest per year over the next 40 years, could deliver abatement of *c.* 15 $MtCO_2$ by the 2050s, providing the substitution benefits of wood and timber products are taken into account… This… would equate to about 10% of total GHG emissions from the UK [in 2050]" (Read et al. 2009, p.xiii). The report also warned that the rate of uptake of carbon dioxide by the UK's forests was decreasing, largely due to declining planting rates since the 1980s and maturation and harvesting of older forests. The authors concluded that, "Private forest owners will require financial incentives to manage land for carbon sequestration… Policy incentives need to be re-designed so that adequate reward is given to the provision of non-market benefits, including those relating to the climate…" (Read et al. 2009, p.xvii).

The UK's Low Carbon Transition Plan (HM Government 2009c, p.153) included an objective to "Encourag[e]… private funding for woodland creation to increase forest carbon uptake." In keeping with this aim, in July 2009 the Forestry Commission published for

consultation a draft 'Code of Good Practice for Forest Carbon Projects' setting out proposed good practice requirements for voluntary carbon sequestration activities in the UK. Even at this early stage, however, the consultation document acknowledged that:

> "Whilst net emissions reductions resulting from compliant schemes will contribute directly to the UK's national GHG targets, the Code will not provide a route to compliance with Kyoto Protocol… linked carbon 'offsetting' or other internationally tradable compliance or voluntary market carbon credits. The generation of international carbon credits would require a mechanism for the retirement of national Assigned Amount Units under the Kyoto Protocol which is currently not possible in the UK…" (Forestry Commission 2009, p.2).

The consultation document also pointed out that, "There are currently no uniform standards applied to UK forestry-based carbon projects, the sector has no trade body, accreditation scheme or consistent basis for verification. As a result there is no consistency to the offer made to prospective customers." (Forestry Commission 2009, p.4). These two quotations neatly illustrate the twin processes of commensuration and differentiation at work and in tension with one another: on the one hand a desire to impose standards and consistency and "as far as possible, alignment with the principles and methodologies used in international carbon offsetting standards" (Forestry Commission 2009, p.5), while on the other, an acknowledgement that international commensuration with other regulatory or voluntary carbon offsets was politically impossible.

The proposed Code of Good Practice evolved into a recognisable carbon accounting standard, the Woodland Carbon Code, first published in 2011 (Forestry Commission 2011; Forestry Commission 2013). The Woodland Carbon Code shares many features with other international voluntary carbon offsetting standards, but is in the difficult position of trying to sell a voluntary credit for woodland creation, denominated in tCO_2e, which is nevertheless not a carbon offset. As of January 2014, 63 projects representing 2,503 ha of forest had undergone validation against the Woodland Carbon Code requirements, resulting in nearly 1.2 $MtCO_2e$ of projected removals over the project lifetimes (which can be up to 100 years). Of this quantity, 430,000 tCO_2e had been sold, mainly to corporate buyers; 120,000 tCO_2e had been allocated to a 'buffer' account as insurance against future reversals of storage, and 650,000 tCO_2e remained unsold.[70] However, project developers speak of excess supply of suitable projects, while at the same time claiming that there is pent-up demand from UK

[70] Data provided by the Forestry Commission to the Carbon Advisory Group, 14 January 2014.

companies for UK forest offsets.[71] Peters-Stanley & Hamilton (2012, p.57) support the latter point, observing: "suppliers report that – like other developed regions and especially in times of economic hardship – European companies increasingly desire to support projects that are closer to their homes and headquarters." It is also worth noting that the amount of new woodland supported by the Code so far (2,503 ha cumulative total) is far below the 23,200 ha/year potential identified in the Read Report (Read et al. 2009).

The previous sub-section has explained how commensuration of UK forest carbon with other forms of forest carbon internationally – and in the negative, with GHG emissions of UK companies – is prevented by a conflict between commensuration processes. The wider process represented by the leading international standards (VCS and the Gold Standard) conflicts with the commensuration process represented by the Woodland Carbon Code, which is thereby forced to define Woodland Carbon Units (WCUs) differently, and awkwardly, as something similar in all respects to other voluntary forest carbon offsets, which is nevertheless not a carbon offset: in the Code's terms, a WCU "does not provide a route to compliance with regulatory carbon reduction mechanisms… or the generation of internationally tradable carbon credits linked to either the compliance or voluntary markets." (Forestry Commission 2013, p.3). If the international voluntary carbon offsetting standards did not exist, or if they in turn did not have to co-exist with regulatory mechanisms such as the Kyoto Protocol, then the Woodland Carbon Code would not have this problem with defining what its units represent.

However, given the fact of this conflict with international standards, the next problem for the UK forest carbon industry is political: as a broad generalisation, the UK Government has historically been suspicious of voluntary carbon offsetting in general, and forest carbon offsetting in particular, as expressed in this quotation from a senior DECC official (speaking in a personal capacity):

> "…the UK doesn't support the voluntary market… we are not fans of anything that… generates any sort of voluntary emissions reduction unit… our sort of justification for that is a) our… aim is for a long-term – one – carbon market that is a compliance market and anything that sort of is an alternative to that is kind of not helpful for our aim; and then secondly… when we've had people lobby us on this before, they've never ever been able to produce evidence that… any of the voluntary standards are robust in a way

[71] Personal communication from multiple attendees at *Opportunities in Woodland Carbon* workshop, Edinburgh, UK, 27 June 2013.

> that would, you know, get a government stamp of approval…" (pers. comm., UK Department of Energy and Climate Change official, 2 May 2013).

The UK Government has in the past actively tried to 'regulate' the voluntary carbon market. In March 2009, following a consultation process initiated in January 2007, the Government launched a Quality Assurance Scheme (QAS) for Carbon Offsetting, which aimed to apply government pressure, via a website and 'quality mark', to direct consumers of carbon offsets to a vetted group of approved offset suppliers, and to particular types of offset, which it limited to CERs, ERUs, AAUs and EUAs (DECC 2011, p.25). The scheme closed in mid-2011, citing low take-up (only four carbon offset retailers had signed up) and cost, at a time of government budget cut-backs:

> "'Since it launched, take-up of the QAS has been disappointingly low and DECC has been required to part-fund the scheme over the past year despite it being designed as self-financing. The carbon market has moved on substantially since the introduction of the QAS and we now believe it is for the market to set best practice for carbon offsetting.' [said a DECC spokesperson]" (Bateman 2011).

The QAS allowed forest carbon offsets to be approved, but only if they had been generated under the CDM, which therefore limited the scope to developing countries only (DECC 2011, p.26). In an earlier internal government discussion paper on the idea of supporting 'domestic' emission reduction projects by issuing them with Kyoto units (e.g. AAUs, or ERUs converted from AAUs via the Joint Implementation mechanism), concerns had been raised about the additionality of domestic abatement actions, beyond the existing mechanisms of cap-and-trade (i.e. the EU ETS) and regulation. The discussion paper noted:

> "Although hosting projects backed by Kyoto compliant credits will in theory have a neutral effect on the UK's net carbon account, it might become harder to actually meet our carbon budgets by allowing other Parties or operators to take credit for emissions reductions taking place in the UK. …it could be said that every domestic project would represent a reduction in our options for the UK Government to take credit for domestic abatement to help meet our carbon budgets." (Defra 2008).

Defra (2008) also raised the issues of possibly counting emission reductions twice, for example both upstream and downstream in a supply chain, or 'double crediting', where for example a reduction in electricity consumption due to an energy efficiency project, if credited, would at the same time free up allowances for electricity generators covered by the EU ETS. Further issues included the need for removals to be permanent, leakage (defined as

an increase in emissions outside the project boundary, for example due to a displacement caused by the project), adverse incentives (e.g. trees most suitable for carbon sequestration not being best for biodiversity), uncertainties in monitoring and verification, and cost effectiveness (for example citing the high cost of developing project-level carbon accounting methodologies). As discussed earlier in this chapter, a variety of technical commensuration issues became entangled with political factors – particularly, in the case of domestic emission reduction projects, the negative impressions associated with the Kyoto Protocol's JI mechanism, which was seen by the UK as a less robust mechanism than the CDM (pers. comm., UK Department of Energy and Climate Change official, 2 May 2013).

However, there are tentative signs that the UK Government may be willing to change its position on domestic forest carbon projects. Since 2009, the Government's non-binding guidance on measurement and reporting of greenhouse gas emissions has included the possibility of reporting emission reductions separately to gross emissions, provided they meet a set of 'good quality' criteria (Defra 2009b, p.50) – which, however, includes avoidance of double-counting and recommends the use of Kyoto-compliant credits in accordance with the Government's QAS for carbon offsetting. The 2009 guidance suggests that companies wishing to make a contribution to domestic projects should communicate this in a different (and clearly more cumbersome) way:

> "Domestic projects cannot normally meet the good quality criteria (most probably in terms of additionality and avoiding double-counting). The carbon value of carbon credits originating from domestic projects may therefore not be clear cut and should not be claimed as an offset. This does not mean that it is always inappropriate to finance domestic projects; indeed doing so would be of benefit in helping the UK to meet its targets efficiently. But unless all the 'good quality' offsetting tests are met, organisations funding such projects should communicate their contribution in another way; for example, they could say: *'Rather than offset our unavoidable emissions and claim the credit for these emission reductions, [organisation name] has contributed £[cost] to [project name] in [location] in the UK. This project is expected to help the UK to meet its national target by reducing emissions by [number] tonnes of CO_2e from [start date] to [end date]'*." (Defra 2009b, p.51).

In 2011, Defra supplemented its guidance with an Annex on reporting emissions and removals from domestic woodland creation, specifically allowing reporting entities to claim emission removals from projects certified under the Woodland Carbon Code, as long as they are not counted twice by different organisations (Defra 2011a). The guidance recommends that Woodland Carbon Code removals should be shown as a separate line after reporting gross emissions, then taken into account in reporting net emissions. Nevertheless, the

guidance is still obliged to point out, "GHG removals associated with UK-based woodland creation represent a contribution to helping the UK to meet its emissions reduction targets. They cannot and should not be presented as carbon offsets or as tradable units on international carbon markets." (Defra 2011a, p.9).

Also in 2011, the UK Government consulted on options for implementation of a requirement under section 85 of the Climate Change Act 2008 to make regulations (under the Companies Act 2006) by 6 April 2012 that would require the directors' report of a company to include information about GHG emissions, or to explain to Parliament why no such regulations were made (Defra 2011b). A previous Defra report had looked into the evidence for whether GHG reporting contributed to the UK meeting its climate change targets (Defra 2010; see also Kind et al. 2011). The outcome of the consultation was a decision to require all listed UK companies to include GHG emissions information in their annual reports for reporting years ending on or after 30 September 2013. This was implemented (a year late, on 12 June 2013) via the Companies Act 2006 (Strategic and Directors' Reports) Regulations 2013 (HM Government 2013). The Government then issued updated environmental reporting guidance (Defra 2013) which continues to reference and support *voluntary* reporting of Woodland Carbon Code emission removals, but does *not* include it within the scope of mandatory reporting requirements.

In 2013, the Forestry Commission asked ClimateXchange, an interface between Scottish universities and the Scottish Government, for a study to identify options for the operation of carbon markets in the UK which could recognise the contribution of UK forests. I carried out this research, together with Till Neeff, an independent consultant. We analysed a variety of options, including the possibility of forests being recognised in both regulatory and voluntary carbon markets, but concluded that the only politically realistic and technically feasible options involved the UK Government either allocating AAUs directly to forest owners in recognition of 'additional' removals, or establishing procedures to cancel Kyoto units to enable internationally tradable voluntary carbon credits to be issued under the VCS, Gold Standard, Woodland Carbon Code or potentially, other standards (Ascui & Neeff 2013). Supported by this recommendation, in September 2013, the Chief Executive of Confor (the Confederation of Forest Industries), supported by ten other forestry and carbon offsetting organisations and industry bodies, wrote to the Minister for Environment, Food and Rural Affairs requesting a procedure to be established for the cancellation of Kyoto units against

woodland carbon removals (Goodall 2013). The letter points to the potential economic and climate change benefits of incentivising woodland creation in the UK, and argues that:

> "…many businesses, although interested in the concept of carbon mitigation via UK woodland creation, are afraid of the suggestions of 'double counting' that may arise from their investment. The need to use nuanced language to explain their commitment, in a sphere where simplicity is important, is a disincentive." (Goodall 2013).

The Minister has since responded to the letter, expressing an openness to considering the proposal and asking for further evidence of the benefits (pers. comm., UK forest carbon developer, 14 January 2014). Confor and the other industry representatives are currently working on this, with support from the Forestry Commission. However, the sheer complexity of accounting under the UK's overlapping Kyoto Protocol and Climate Change Act targets (see Annex 1) is in itself a barrier to making further changes to the accounting system, even if the political will is there.

8.3. Discussion

The story of forest carbon accounting in the UK illustrates the immense technical, cognitive, social and political *work* that is required to make 'carbon' comprehensible, quantifiable, accountable and tradable – in short, commensurable – in carbon markets. I believe the case study demonstrates the following key points.

In the first place, the early phase of forest carbon offset development in the UK (from 1997 to 2006) clearly illustrates that successful commensuration depends on much more than purely technical processes of physical measurement, comparison, and expression of different quantities in terms of a common metric. The controversy over forest carbon offsets in this early phase shows how technical debates (about issues such as measurement, modelling, uncertainty and permanence) became inextricably enmeshed with social power struggles (who benefits from carbon offsetting, by how much, which social groups 'own' the symbolic value of the tree, suspicions about 'greenwash' and celebrity endorsements) and wider politics (becoming embroiled in the international politics of responsibility for emissions, particularly once the Kyoto Protocol came into force in February 2005).

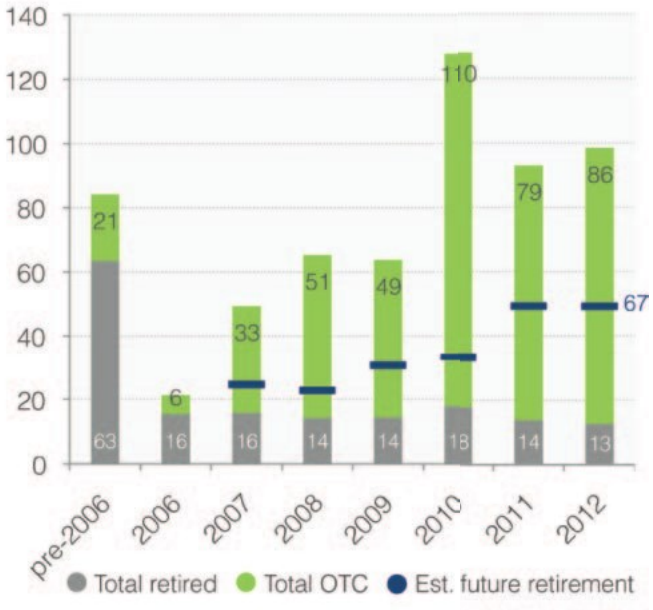
At a more conceptual level, I believe the evidence of an intrinsically moral dimension to commensuration – highlighted by the absence of acceptance of carbon offsetting by certain environmental NGOs – could be a useful addition to the model of commensuration proposed

by Levin & Espeland (2002). The latter involved three dimensions: technical commensuration, value commensuration (expressing the relationship between technically standardised units in terms of relative monetary value) and cognitive commensuration (when the world-view resulting from the previous commensurations becomes tacitly accepted and influences further perceptions). In the case of carbon offsets, I would argue that a fourth dimension of *moral* commensuration comes before value commensuration: it is only once the moral equivalence between one's own emissions and emission reductions elsewhere is accepted, that transactions in carbon offsets take place. This is a possible area for further research.

Returning to the case study, the offsetting industry responded to the technical and moral challenge partly with discursive attempts to deflect NGO and media criticism and control key terms of the debate, and also by taking pre-emptive action to institutionalise an apparatus of self-regulation through the creation of standards and related infrastructure, including alliances and representative bodies (Bumpus & Liverman 2008; Lovell et al. 2009). While the UK was in many ways at the forefront of such efforts (other leading countries being the USA and Australia), this institutional apparatus quickly became internationalised, and appears to have been largely successful in securing the on-going growth of the offsetting industry, illustrated in Figure 17 below. The NGO/media backlash peaked in 2006 and early 2007, and whilst controversy has not entirely dissipated, dozens of key environmental NGOs are now institutionally involved in the standardisation of carbon offsetting, via the Gold Standard in particular (which counts 85 NGOs among its supporters).[72]

[72] See http://www.cdmgoldstandard.org/about-us/governance (accessed 19 February 2014).

Figure 17: Volumes transacted and retired in the 'over the counter' voluntary carbon market, 2006 to 2012



Source: Peters-Stanley & Yin (2013, p.13).

However, while this institutionalisation of commensuration may have saved the carbon offsetting industry internationally, it was unable to preserve forest carbon offsetting within the UK. Early enthusiasm shown by pop and rock stars for planting trees in the UK to offset their lifestyles evaporated in the face of media and NGO criticism. Later, however, the challenge to UK forest carbon offsetting came not so much from this early controversy, but rather from the institutionalised response to it, in the form of double-counting prohibitions within the major international voluntary carbon offsetting standards, combined with UK Government disaffection for voluntary offsetting and domestic projects in general, and forestry in particular. This has continued to make it very difficult for UK forest owners to monetise the carbon value of their forests. In a sense, therefore, UK forest carbon is 'made *not* the same' as other carbon offsets, not because these two things are fundamentally incommensurable in the way that Espeland (1998) argues land and money were to the Yavapai Indians, but rather as an almost accidental by-product of the overlap between two different commensuration processes. One the one hand, from a purely 'market' perspective, we have buyers and sellers in the UK willing to transact something which the sellers feel they 'own' and the buyers are also interested in 'owning' – the carbon value represented in their forests. However, they are prevented from doing so, not by the rule of formal law (to the best of my knowledge, the UK does not have a specific legal framework specifying ownership of forest carbon, unlike Australia, for example – see Hepburn [2009]) but rather by 'soft' self-regulatory standards which create problems of perception and credibility, in the

absence of formal UK Government support (such as a procedure for cancelling Kyoto units in recognition of 'additional' forestry removals). This highlights the fact that carbon accounting involves multiple levels of governance and is heavily influenced by both state and non-state actors – unlike the earlier (and, by comparison, much simpler) US sulphur dioxide market, where Levin & Espeland (2002, p.121) had drawn attention to "the crucial role [of] the state… in creating and coordinating the various kinds of commensuration required."

The concept of framing is applicable here in two ways. At one level, the UK Government and a typical UK forest carbon developer see precisely the same thing – carbon sequestered in UK forests – quite differently, due to their different framings of the issue. The difference in perspective is quite profound: one UK forest carbon developer has asked me, in all seriousness, if they could sue the UK Government for appropriating 'their' forest carbon, after I had explained how all UK forests, whether public or private, are counted in the UK national inventory and give rise to credits which the UK can use to meet its Kyoto Protocol target (pers. comm., UK forest carbon developer, 27 June 2013).

At another level, each commensuration process, such as a new carbon offsetting standard or set of rules around national accounting, represents a kind of framing. When such commensuration processes proliferate within a particular domain, this can give rise to *difference*, simply due to the on-going interactions between institutionalised processes and the social or political exigencies that drive alternative framings and commensuration processes. For example, the inclusion of both domestic and international aviation emissions in the EU ETS from 1 January 2012 destroyed the symmetry that had previously existed between EU ETS and Kyoto Protocol accounting, because international aviation emissions are not within the scope of the Kyoto Protocol (while domestic aviation emissions, and those from the original EU ETS sectors, are). This required the creation of a new EU registry and accounting system to accommodate this, and led to differences between aviation and non-aviation, and Kyoto-relevant and non-Kyoto-relevant, allowances, within a market originally premised on a single uniform commodity (for a detailed explanation see Prag et al. 2011, pp.49–56). The complexity of UK carbon accounting under the Kyoto Protocol and Climate Change Act 2008 (see Annex 1) is already a challenge to everyday comprehensibility, yet from 2013 onwards, *three* different targets and accounting frameworks will apply in parallel: Kyoto Protocol accounting for a 20% reduction, on average, on 1990 levels over a second commitment period which will run from 2013-2020; Climate Change Act accounting for the

second carbon budget period which runs from 2013-2017; and European accounting for the EU's 2020 target, which sounds superficially similar to the Kyoto Protocol target (a 20% reduction by 2020) but which in fact differs subtly in geographical coverage (covering the UK and Gibraltar), scope (including international aviation, excluding LULUCF, including different GHGs and using different Global Warming Potentials) and in being a target to be reached *by* 2020, rather than *on average* over 2013-2020 (for details see European Commission 2012, pp.2–3; Ascui & Neeff 2013, pp.10–11; DECC 2013b, pp.7–8).

Looking closely at the detailed operation of carbon markets and other managerial, target-based responses to climate change reveals not only the practices of commensuration at work in 'making things the same' (MacKenzie 2009), but also how commensuration simultaneously creates its opposite: difference. What I hope to have demonstrated in this case study is that difference exists not only with what is *outside* the frame of what can be commensurated (what Espeland [1998] terms 'incommensurables') but that it can also be created by conflicts *between* frames of commensuration. Such conflicts can be obvious controversies, such as the early NGO opposition to carbon offsetting, but they can equally be the unintended consequences of the proliferation of commensuration activities, each responding to subtly different social and political contexts (as in the case of the UK's three sets of post-2012 targets). Whether unintended or deliberate, difference matters: for example, the unexpectedly poor performance of afforestation/reforestation under the CDM has been attributed to the specific accounting choices which made CDM forest carbon credits temporary, rather than permanent like all other CDM credits (Neeff & Ascui 2009).

The early dream of carbon markets and carbon accounting was 'a tonne is a tonne is a tonne' (Brohé et al. 2009, p.xxv) – in other words, everything should be fungible, everything should be commensurable. That dream is now evident as a chimera. There are now literally dozens of different types of carbon, or what MacKenzie (2009, p.452) terms "multiple monies", which, although they may be denominated in a common metric (tonnes of carbon dioxide equivalent), are nevertheless *not the same*. AAUs, CERs, ERUs and RMUs were all created equal under the Kyoto Protocol, but are no longer. For many years now, CERs which carried the stamp of approval of the Gold Standard have fetched a higher price while CERs from industrial gas destruction and large hydro projects have had lower prices. CERs from projects registered after 31 December 2012 are only allowed into the EU ETS if they originate from Least Developed Countries. ERUs from afforestation and reforestation projects have never been permitted in the EU ETS, whereas other ERUs have been. RMUs

may be used for compliance within a commitment period, but may not be carried forward; CERs and ERUs may only be carried forward within certain limits. AAUs may be carried forward without restriction, but a UNFCCC decision[73] taken in Doha in 2012 creates new restrictions on which Parties may *use* these carried-forward AAUs – aimed at eliminating the potential market for Russia's estimated 5.8 billion surplus units (Arvanitakis et al. 2012, p.5) – which will create new classes of AAUs which are definitively not the same as each other, despite having been formally identical pre-2013. The picture becomes even more crowded when we include multiple emission trading schemes and voluntary carbon markets. There is even the case of the north-eastern USA's Regional Greenhouse Gas Initiative (RGGI) denominating its units in short (non-metric) tonnes. The proliferation of commensuration creates difference. To paraphrase George Orwell (1945), all carbon units are equal, but some carbon units are more equal than others.

[73] UNFCCC Decision 1/CMP.8, paragraphs 24-26.

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9. Conclusions

This thesis documents an exploration of carbon accounting, a subject which at the outset of my research had only just begun to be considered from an academic accounting perspective. In the following sections I summarise and discuss my key findings according to the questions motivating the research, reflect on its theoretical implications, and discuss its limitations and some potential areas for further research. Parts of the summaries of chapters 4 and 7 in section 9.1, the last paragraph of section 9.2 and some of the concluding remarks in section 9.5 have been published in the conclusions to Ascui & Lovell (2011); Ascui & Lovell (2012) and Ascui (2014).

9.1. Summary and discussion of key findings

Question 1: What is carbon accounting? How is it understood in different contexts?

Chapters 4, 5 and 6 provide complementary perspectives on these questions. Chapter 4, which reviews the emergence of carbon accounting as a topic of interest in the social and environmental accounting literature, shows that from this particular academic perspective, carbon accounting has mainly been viewed as an element of corporate environmental accounting, with distinct foci of attention on carbon-related management accounting, financial accounting and disclosure. However, there is a growing body of research *about* carbon accounting more generally, as opposed to studies *of* carbon accounting. This includes papers based on chapters 6 and 7 of this thesis (Ascui & Lovell 2011; Ascui & Lovell 2012).

Two major gaps were found in the SEA literature on carbon accounting. The first is the shortage of papers dealing with the specifics of accounting in carbon markets (aside from financial accounting papers which deal with the secondary effects of such markets on companies). 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). Chapters 5, 6, 7 and 8 all provide contributions in this area. The second gap has to do with interdisciplinary research, and demonstrating the kind of engagement of research with practice and education called for by Bebbington (1997). Many of the reviewed papers have called for greater interdisciplinary cooperation, and a range of different disciplines (principally accounting, natural sciences and engineering) are represented in the reviewed papers, but there is relatively little evidence of truly interdisciplinary work, relatively little engagement with practitioners, and only a single contribution so far on education (de Aguiar & Fearfull 2010). In particular, technically complex areas such as

biogenic carbon accounting would benefit from greater scrutiny by social scientists. Again, I hope to have made a contribution to this, in chapters 5 and 8 in particular.

On the positive side, chapter 4 shows that, although carbon accounting was almost completely absent from the SEA literature until 2007, from 2008 onwards it has quickly grown into a topic of considerable interest. The number of researchers involved and extremely rapid increase in publications point to a fast developing field with significant future potential. Carbon accounting is drawing new researchers into the SEA field, as well as engaging more established SEA researchers. The fact that the practices of carbon accounting extend far beyond the corporation means that there is an opportunity for research in this area to help the SEA 'project' to keep extending its own margins (Miller 1998) beyond the predominant focus on the corporation as the relevant accounting entity (Lehman 1999). In other words, researching carbon accounting could itself be emancipatory: attracting new researchers, encouraging greater interdisciplinary cooperation, offering tremendous opportunities for engagement with practice and education, and helping to imagine new accountings free from the "shackles" of conventional accounting (Gray 2002, p.692).

Chapter 5 examines the emergence of carbon accounting in practice. It shows that carbon accounting comprises a wide range of practices, many of which have evolved in relative isolation from one another. Scientists have carried out a form of accounting for the global carbon cycle for over a century, and started using the term 'carbon budget' from the mid-1960s, as these measurements of the carbon cycle became increasingly problematized by growing awareness of the implications of climate change. The chapter shows that this scientific framing of carbon accounting overflowed into a variety of other areas, leading to the current proliferation of practices, starting around 1988, at least six years earlier than previously thought (Stechemesser & Guenther 2012; Perman 1994). This overflowing occurred during a pivotal period when climate change transitioned from an issue of mainly scientific to wider social and political concern.

Many different terms are used, sometimes to describe the same practice, at other times to describe different practices that can nevertheless collectively be identified as carbon accounting. While there is inevitably some circularity in my argument here (I identify these practices as carbon accounting, and carbon accounting as the sum of these practices) I hope that the conceptual relatedness of these practices is evident from the narrative, and also in the expanded definition in Table 5 (p.138). The specific term 'carbon accounting' can be traced

at least as far back as 1991, and has a long tradition of use in relation to quantifying the carbon stored and released in forests and other forms of biomass. It is also used in connection with national greenhouse gas inventories, and, since 2008, as a more generic term for many other forms of carbon accounting, with increasing frequency and scope of coverage. The chapter also traces the early history of the key terms 'carbon offset' and 'carbon footprint', showing that the latter term, like 'carbon accounting' more generally, is understood differently and ownership is contested by different communities. Finally, the chapter concludes that carbon accounting has been too narrowly defined by most commentators, and proposes an expanded 'pick and mix' definition that covers a much wider range of practices than previously considered within the scope of other definitions of carbon accounting. The chapter, and the thesis as a whole, provides numerous examples of the interdependencies which justify thinking of these many different practices collectively as 'carbon accounting'.

Chapter 6 argues that these different practices of carbon accounting represent fundamentally different conceptions of what carbon accounting is, how it should be done, and by whom. It proposes that five major frames of physical, political, market-enabling, financial and social/environmental carbon accounting can be identified. These frames represent key world-views that can be associated with different objectives, terminology, methods, institutions and expertise that together characterise distinct communities of practice. There are relationships between frames, yet the rapid evolution, proliferation and complexity of carbon accounting practices has led to compartmentalisation of knowledge and expertise, such that what is problematic within one frame may well be uncritically accepted within another, or vice versa. I hope that by opening up the 'space' of carbon accounting, through an expanded definition, identifying key frames and communities of practice, I have contributed to dialogue between different world-views, or a 'dialogic' approach to engagement with the issue (Bebbington et al. 2007). The chapter also draws attention to the existence of a number of specific controversies which could benefit from further frame-reflective analysis, such as the treatment of biomass combustion as carbon-neutral under the Kyoto Protocol and various national legislation, or the use of somewhat arbitrarily determined global warming potentials (GWPs) in commensuration of different greenhouse gases, which in turn influences the relative weight given to different mitigation options. Thus, the results we can expect from carbon management and carbon markets depend to a significant extent on a range of technical carbon accounting choices which easily become overlooked or 'black-boxed' (Latour 1999) within the world-view of a single frame. Appreciating that our responses

depend on different conceptions of carbon accounting, and understanding where these conceptual differences come from, is therefore important as a first step towards more constructive dialogue, mutual learning and the creation of more effective responses to climate change.

Question 2: Who are the principal communities involved in carbon accounting, and how do these communities interact?

Chapter 7 draws attention to the politics of carbon accounting at the level of communities: who defines it, who claims to have competence in it, and how such claims are justified and reinforced. It shows that multiple communities are involved in carbon accounting, each framing it in their own discourse, with their own standards, techniques and practices. At a high level, the communities associated with the five major frames of carbon accounting can be characterised as: scientists (physical carbon accounting); government-appointed experts (political carbon accounting); carbon market experts (market-enabling carbon accounting); accountants (financial carbon accounting) and sustainability experts (social/environmental carbon accounting). The first four of these communities are relatively cohesive: participants would tend to recognise one another, attend the same conferences or meetings, and share certain knowledge-sets, tools or standards, such as the IPCC guidelines for national greenhouse gas inventories (IPCC 1997c; IPCC 2003; IPCC 2006) in the case of government-appointed experts involved in political carbon accounting. The fifth community is more diverse, involving several disciplines including accounting, ecological/environmental economics and engineering. This means that this frame is the most open to contested claims of 'ownership' and expertise, both within and between frames.

The corporation represents a site of potential conflict between the communities of financial carbon accounting (indisputably the domain of accountants) and social/environmental carbon accounting, where accountants share the field with a range of specialist and generalist consultancies as well as internal functional managers, whose expertise is more likely to draw on the disciplines of ecological/environmental economics or engineering. Corporate (or, more generally, organisational) carbon accounting can be further sub-divided into physical and non-physical (monetary and strategic) dimensions, as well as according to whether it is produced for internal or external accounting and reporting purposes. Accountants have been involved in setting standards for physical, external organisational carbon accounting since at least 2001, but as only one of several different communities active in this field, and against a backdrop of initial reluctance and lack of awareness from rank-and-file members of the

profession. Financial reporting of emission rights surfaced as a significant issue for large companies in the run-up to the 2005 start of the EU ETS, and highlighted an area of carbon accounting where accountants could indisputably claim competence. This occurred at roughly the same time as a broader strategic push by the accountancy profession into other forms of organisational carbon accounting, particularly the external disclosure and management interpretation of physical and strategic carbon-related information. Competence is also being claimed in virtually all aspects of internal carbon management accounting (Chartered Institute of Management Accountants 2010) although the evidence to date suggests that accountants are not yet actively involved (Burritt et al. 2011).

The broader participation of accountants in carbon accounting has many positive aspects, and I hope to have shown that the interaction between the accountancy profession and the social/environmental disclosure community in forming the Carbon Disclosure Standards Board and producing the first Climate Change Reporting Framework has been productive, and beneficial for both sides. However, I believe that this initiative should not go un-scrutinised. The involvement of accountants and efforts to align the Climate Change Reporting Framework with financial reporting standards has led to the use of technical terminology and cross-referencing to other financial accounting concepts and documents which may serve as a barrier to non-accountants. It is also worth remembering that incorporating carbon accounting information in company financial reports is not the only way such information might be collated or presented.

By drawing attention to the distinct frames of carbon accounting and who is involved in them, I hope to have provided a conceptual and practical basis for these different communities to work more closely together. Boundary organisations such as the CDSB can play a vital role in bringing together experts from different communities to facilitate cooperative action, but this first requires a mutual recognition of the basis for, and value of, respective competences. For example, the perspective of a 'physical' carbon accounting expert could potentially highlight and contribute to the development of practical methods for accounting and reporting on an organisation's carbon *stocks* or potential emissions (most standards, including the GHG Protocol and CDSB's Reporting Framework currently only cover carbon *flows* or current emissions). Recent debate has highlighted the importance that such information could have for company valuations in the oil and gas sector (Leaton 2011; Leaton et al. 2013; ACCA & Carbon Tracker 2013) and similar principles could potentially be applied to companies with substantial holdings of stocks of high-GWP ozone depleting

substances (Ascui et al. 2013), forests, peatlands or, in future, biochar or geologically sequestered carbon dioxide. Carbon market practitioners could work collaboratively with accountants to develop financial reporting guidance on how to value and report on carbon offsets created under different standards. Conversely, organisational accountancy practices and skills could provide insights to 'political' carbon accounting actors debating new rules for monitoring, reporting and verification of national emissions under a future international climate change agreement (see discussion in Prag et al., 2011). Any organisation with an interest in progressing carbon accounting may find it useful to consider such perspectives and recognise the contribution that experts from different communities can bring to the debate.

Question 3: How might an improved understanding of carbon accounting help to resolve accounting-related problems in carbon management and markets?

Carbon accounting is absolutely essential to carbon management and markets. Without some kind of calculative apparatus there would be no way of assessing whether responses to climate change were having any effect. Markets in intangible rights to emit gases to the atmosphere and transactions in reductions against hypothetical baselines are literally brought into being by a variety of accounting practices and processes including commensuration and standardisation. The sources of human-induced climate change – principally emissions of carbon dioxide from fossil fuel combustion and deforestation, and methane (CH_4) and nitrous oxide (N_2O) from agriculture – are distributed across the globe and present in virtually every sector of the economy, making carbon accounting essential to the management of a pervasive, multi-layered, multi-stakeholder, 'super wicked' (Lazarus 2009) governance problem. Therefore the first point that I hope this thesis has made is that carbon accounting *matters*.

The second point is that it also matters what carbon accounting is understood to mean, because this in turn frames our understanding of how it should be done and what constitutes success or failure. I hope to have shown that there is no single answer to these questions, but that appreciating the existence of multiple frames of carbon accounting at least opens up the possibility of considering alternatives.

The third point, illustrated mainly in chapter 8, is that carbon accounting involves considerable technical, cognitive, social and political *work.* This is shown up in the negative through the case study on UK forest carbon accounting, which demonstrates how difficult it

can be to achieve commensuration, or in this specific case, acceptance of UK forest carbon as an eligible offset. The case study shows how technical debates over issues such as measurement, modelling, uncertainty and permanence became enmeshed in wider social and political power struggles. Conversely, this suggests that successful commensuration requires not only the development of technical solutions such as measurement techniques and standards, but also a degree of social and political support. This may necessitate the involvement of many different stakeholders, as carbon accounting typically involves multiple levels of governance and is heavily influenced by both state and non-state actors.

Finally, the case study offers preliminary support for the proposition that an improved understanding of carbon accounting – in particular, an understanding of context, framing, and alternative approaches – could contribute to resolving accounting-related problems in carbon management and markets. I believe it has been helpful for stakeholders such as UK forest carbon developers to understand that they see carbon sequestered in UK forests quite differently to the UK Government. The answer is not necessarily to press ahead with the commensuration process represented by the Woodland Carbon Code, but to address the political reservations that key UK Government departments have about carbon offsetting in general and domestic projects and forestry in particular, with a political solution (creation of a procedure for cancellation of Kyoto units in recognition of truly additional forest carbon sequestration). However, it remains to be seen whether these political reservations can be convincingly countered, and the ever-increasing complexity and overlap between carbon accounting frameworks and targets creates further barriers to resolution of the issue.

9.2. Theoretical implications

This thesis did not set out to test a pre-existing theory against a new set of empirical evidence; rather, it has made selective and interdisciplinary use of four main theoretical frameworks (framing, commensuration, epistemic communities and boundary-work) to help develop an original interpretive understanding of a new, rapidly evolving area of both practice and research. For this type of research, "the empirical detail is not mere confirmable or refutable "data" for some prior theory but… *becomes* the theory for this particular phenomena…" (Laughlin 1995, p.67). Therefore the primary conceptual contributions of the thesis are specific to the subject of carbon accounting (as summarised in the previous section) and not necessarily generalizable beyond this. Nevertheless, having used these four theoretical frameworks in combination with one another, I offer the following reflections, as observations and suggestions for further research.

I found the combination of approaches to framing from the policy discourse and economic sociology literatures (in particular Rein & Schon [1993] and Callon [1998a]) more useful than only a single approach on its own. The policy discourse view of framing is focussed on policy controversies as manifestations of conflicts between multiple frames, whereas the economic sociology literature tends to focus on a single, dominant frame and how it deconstructs itself through 'overflowing'. The former seemed clearly applicable to carbon accounting, as it encompasses such diverse practices, communities and objectives. However, there is also value in considering what is excluded by any individual frame, which is not necessarily a subject of any overt controversy. The policy discourse view of framing seems less sensitive to very unequal power relations, as in order for there to be a visible controversy, an alternative framing needs to have achieved some degree of parity with, or at least the ability to challenge, the dominant framing in the first place. With respect to overflows, Callon (1998a, p.257) invites us to "establish who is responsible for them and who is affected by them." This seems a useful approach to take in accountability research, and it may also be useful applied back to analysis of policy controversies, drawing attention not just to the frames of reference corresponding to the participants in a controversy, but to further perspectives that each frame excludes, and the actors who are affected by these exclusions.

I also found it helpful to combine the concepts of commensuration and (both types of) framing. Commensuration clearly involves framing: disparate things first have to be seen as being within some kind of frame that enables relations to be drawn between them, and implicit agreement on a common metric. MacKenzie (2009) and Lohmann (2009) have both discussed commensuration as framing, specifically in relation to carbon accounting. However, the commensuration literature tends to focus, like the economic sociology literature, on powerful, dominant commensuration processes: "Commensuration can radically transform the world by creating new social categories and backing them with the weight of powerful institutions." (Espeland & Stevens 1998, p.323). This is again useful from an accountability perspective, because it actually serves to highlight the relatively less powerful perspectives that the dominant framing excludes, like the non-monetisable land values of the Yavapai Indians in Espeland's (1998) study. However, I have also found it useful to think about commensuration as occurring simultaneously in multiple frames, where the interactions between what is considered commensurable and what is not are not necessarily to do with power relations or incommensurables. I believe my case study of UK

forest carbon in chapter 8 shows that parallel processes of commensuration taking place within different frames may lead to incompatible outcomes, and that while such differences may be politically driven, they may also be quite unintended.

I think that further close examination of the detailed operation of carbon markets and other managerial, target-based responses to climate change could be instructive in revealing not only the practices of commensuration at work in 'making things the same' (MacKenzie 2009), but could also provide cases showing how commensuration simultaneously creates its opposite: difference. In other words, I think that differentiation – as a kind of commensuration in reverse, making things that otherwise seem the same, different – is a process worthy of closer attention and theory development.

Another possible area of theoretical development, arising from the discussion of the early controversy over carbon offsetting in chapter 8, has to do with the three dimensions of commensuration proposed by Levin & Espeland (2002) and further exploring the function of a fourth 'moral' dimension. I am not suggesting that morality is absent from this model of commensuration; for example, Espeland & Stevens (1998, p.326) point out that "Commensuration sometimes transgresses deeply significant moral and cultural boundaries." Elsewhere, Espeland & Vannebo (2007, p.39) observe, "measurement is a moral issue." However, morality is usually invoked in the context of incommensurables, or what lies outside or is transgressed by the frame of commensuration; I am interested in the implication that therefore successful commensuration requires moral acceptance of the equivalence between two otherwise different things. If so, what is the 'work' involved in creating such moral commensuration? How are differences 'measured' and resolved? This would require further exploration of the legal and ethical literature on commensuration (Heinzerling 2000; D'Agostino 2000; D'Agostino 2003; Skopek 2010).

Finally, it has also been helpful to consider the concepts of framing, boundary-work and epistemic communities together. Professional training, expertise, shared language and practices have been critical to the conception and subsequent development of different frames of carbon accounting. Ideas about boundary-work therefore complement the broad scope of framing theory, by focussing in more detail on the interactions between frames and the importance of interdisciplinary and inter-organisational activity in driving policy change. The theory of epistemic communities, with its focus on small networks of elite technical experts (originally developed from research with scientists) has significant scope to be

extended to other transnational groups of non-scientists, as with my case study on the CDSB in chapter 7, allowing a closer examination of precisely *who* is involved in boundary-work. However, theories of epistemic communities and boundary-work both largely ignore financial interests: experts are presumed to have other motives for engaging on an issue and working to bring about change. Given that the potential financial gain to large accountancy firms in setting carbon accounting standards – defining the space they wish to occupy – is considerable, this is an area that calls for greater practical scrutiny and related theory development.

9.3. Limitations

This thesis is the product of a particular point in time (2008-2014), when, as I have shown in chapter 4, the topic of carbon accounting started to emerge in social and environmental accounting research. Its broad interdisciplinary nature is due in part to the fact that it really was not at all clear at the outset what carbon accounting actually meant, let alone how it should be theorised or what might be priority areas for research. Exploratory, wide-ranging work has value in mapping out the terrain of a new area of research, but misses out on the depth and conclusiveness that might otherwise be achieved by more narrowly focussed research at PhD level, in a more established area. If I were starting over at this point in time, I would probably find it more satisfactory to focus on a narrower scope and seek to test or develop a particular theoretical framework (such as commensuration in forest carbon markets) more conclusively.

The thesis is also a product of my own personal circumstances as a practitioner of carbon accounting, transitioning to an academic role. I have relied extensively on my personal experience and on-going participant observation to inform this exploratory research. As I have acknowledged, I cannot claim to be an objective, impartial observer of my data. My preconceptions, conditioned by my experience of the subject of this research, have undoubtedly influenced what I have looked for, as well as how I have interpreted it. There has definitely been a degree of circularity in my approach to understanding what carbon accounting means, who it involves and how these communities interact, insofar as I have not started with a blank slate on any of these questions. However, it is equally true that my own conceptions have evolved considerably over the course of this research, and even with a circular approach, constant iteration, examination of new data and questioning of assumptions can still produce genuine progress. My prior experience has also been a strength in terms of providing me with access to key informants and the deliberations of various

standard-setting bodies. With hindsight, however, I could have made more use of recorded interviews with key informants to validate my key findings, in several parts of the thesis. Chapter 7 could also have benefited from application of one or more methods of social network analysis (Knoke & Yang 2008) to identify and map the communities involved in the CDSB in a more robust way, as well as in-depth discourse analysis of recorded interviews with participants to analyse their shared beliefs and values, or *episteme*.

Another fundamental limitation has had to do with doing this research part-time, spread out over five and a half years. Parts of the thesis have been written at different times, not necessarily in the order in which they appear, and some parts have been published up to three years before completing the thesis, thereby crystalizing my conclusions at that particular time and potentially constraining later findings. Also, the field of carbon accounting has evolved considerably over this period, both in terms of practice and research. As a result, perhaps some of the earlier findings, such as the five frames and defining a broad scope of carbon accounting, now seem relatively self-evident, whereas they were not so at the time.

9.4. Areas for further research

There is tremendous potential for further research in carbon accounting. I hope that one of the main contributions of this thesis has been to show that there are connections between many different practices of carbon accounting, which might previously have been viewed in isolation from each other. There is therefore a lot to be learnt from taking a critical, frame-reflective and interdisciplinary approach to analysing individual practices of carbon accounting, in full awareness of alternative framings and practices.

Some examples of possible areas for further research of this kind 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 (GWPs) used to commensurate different greenhouse gases needs further attention from social scientists, 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 & Ahuja 1990; Shine et al. 2005; Plattner et al. 2009). Some other ‘black boxes’ which could benefit from external

illumination include the first order decay models used in accounting for hypothetical methane abatement from a range of different types of CDM project (Lazarus et al. 2010) and the allometric equations used to estimate various pools of carbon stored in soils and forests (IPCC 2003).

I am interested in comparing the development of "private regulation" (Bebbington 2013, p.3) of carbon accounting (non-government regulation, such as the CDP, CDSB, VCS, Gold Standard, etc.) with similar developments in regulation, standardisation and institutionalisation of accounting for other environmental issues, such as water, biodiversity and ecosystem services. In many ways carbon accounting has leapt ahead of accounting for other aspects of the environment: either a model to emulate, or an illustration of the dangers of extreme commodification and marketization, depending on one's point of view. On the other hand, carbon was not the first environmental issue to be commodified: other early tradable environmental commodities included wetlands, water rights and fisheries, besides the better-known US SO_2 trading scheme (Womble & Doyle 2012; Holm & Nielsen 2007; Johnston et al. 2008; Chan et al. 2012). Nevertheless, it appears that a new wave of enthusiasm for environmental markets and 'natural capital' accounting is underway, no doubt influenced by the example of carbon markets and carbon accounting; at the same time, a variety of 'carbon' standards have recently repositioned themselves as broader 'ecosystem services' or 'environmental accounting' standards, probably in part due to downturns in major carbon markets. In their latest report on the voluntary carbon market, Peters-Stanley & Yin (2013, p.xiv) talk about market players "developing a new lexicon around the delivery of vulnerability reduction, health, and other public benefits associated with private sector interventions" – elsewhere referring to "programs like the Higher Ground Foundation (exploring vulnerability reduction offsets), the Water Benefit Partners (exploring water benefit certificates), and the Women's Carbon Standard (recognizing women's issues and contributions in project development)…" (p.xii). The latest (2013) version of the Plan Vivo standard has renamed itself 'The Plan Vivo Standard for community payments for ecosystem services programmes' (Plan Vivo 2013) and the latest consultation draft of the CDSB Framework (Edition 2.0) now aims to cover disclosure of "environmental" rather than "climate-change related" information (CDSB 2014; CDSB 2010). It will be interesting to observe these regulatory transitions as they progress.

Finally, I would like to note that carbon accounting has tremendous potential to be disruptive, challenging the hegemony of vested interests which have powerfully dominated

the economy and politics across the globe for the past two centuries: namely those interests which are based on the appropriation and continued exploitation of fossil fuels, which merge with broader interests based on the principle of eternal economic growth measured in conventional terms such as GDP. But it will not necessarily be disruptive – it may just as easily end up supporting the status quo. At some levels this has long been recognised, with strong debates around national-level accountability, carbon markets and offsetting in particular; but other forms of carbon accounting, for example corporate and product-level, have received relatively less politically critical attention. It would be a mistake to assume that these forms of carbon accounting are any less political. For example, the recent proposed changes to accounting and reporting of scope 2 emissions by major public and private regulators (CDP 2013; Defra 2014; GHG Protocol & WRI 2014) seem to be heavily influenced by a coalition of vested interests: companies wishing to meet their emission reduction targets more cheaply, and suppliers of 'green' electricity that is already mandated to be produced. The proposed use of 'contractual' grid emission factors by a minority of reporting companies in effect allows them to shuffle the responsibility for 'brown' electricity onto the majority of households and businesses that do not report. In future, it will be important to continue to pay careful attention to exactly whose interests are served, and whose are silenced or excluded, by the many different options for how we do carbon accounting.

9.5. Concluding remarks

In summary, I hope that this thesis has helped to *make carbon count*: that it has shown that it matters how we interpret what carbon accounting is, who it involves and how it should be done; that, despite many challenges, it can help with holding responsible parties to account, setting targets, measuring performance, applying sanctions and incentives; thus bringing something previously *not counted* or priced within the scope of new markets and management activities; and thus that it has a vital role to play in society's response to climate change.

Researching carbon accounting is important, in part because it is conceptually contested, meaning many different things to different people, and also because it is so relevant to policy and practice. Unacknowledged and unresolved tensions in carbon accounting can undermine confidence in climate science, policies, markets and reporting. 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; Andrew &

Cortese 2011; Solomon et al. 2011; Dragomir 2012; Haigh & Shapiro 2012; Sullivan & Gouldson 2012); fails to incentivise tropical countries to reduce deforestation (Eliasch 2008; Neeff & 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. Engagement with the detail of the 'nuts and bolts' of carbon accounting is essential, as these apparently technical details can have major implications, and it is only by opening them up to rigorous scrutiny that we can make progress, both conceptually and practically. In short, carbon accounting research, particularly if it is interdisciplinary, collaborative and frame-reflective, provides significant potential for constructive learning and positive policy change. I believe that it is time to acknowledge carbon accounting as a new research agenda, worthy of investigation in itself (Burchell et al. 1980), as well as in its many practical applications.

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Annex 1: UK forest carbon accounting under the UNFCCC, Kyoto Protocol and Climate Change Act 2008

The UK, together with most other developed countries, is required to account and report annually for its national greenhouse gas emissions and removals under two international carbon accounting frameworks: the UNFCCC and its subsidiary instrument, the Kyoto Protocol (KP). Although the two frameworks are closely related, they have different purposes and coverage. Reporting under the UNFCCC meets scientific and policy objectives and is relatively comprehensive, including all significant non-natural sources of GHG emissions and removals within the national boundary, including from forestry as a sub-sector of the 'Land use, land-use change and forestry' (LULUCF) sector. However, it does not give rise to any benefits or obligations, and hence carries no financial value. Kyoto Protocol accounting, on the other hand, has the more specific purpose of measuring compliance against each developed country's KP emission reduction target. Hence KP accounting gives rise to new benefits and obligations which have both financial and reputational importance for the state. This involves commensuration of physical emissions and removals with something purely conceptual: tradable emission rights.

In terms of physical emissions and removals, the main difference in coverage between UNFCCC and KP carbon accounting has to do with the LULUCF sector, where KP accounting is far less extensive, including only (for the first commitment period, 2008-2012):

1. Net emissions and removals from direct, human-induced afforestation, reforestation and deforestation activities (mandatory under KP Article 3.3); and
2. Net emissions and removals from forest management, cropland management, grazing land management, and/or revegetation (optional under KP Article 3.4).

For the second commitment period, from 2013-2020, accounting for forest management will become mandatory, and wetland drainage and rewetting is added to the list of optional activities.[74]

Within the second set of optional activities, the UK has opted (in the first commitment period) to include forest management only. Land can only be classified under one activity,

[74] UNFCCC Decision 2/CMP.7.

with the mandatory activities taking precedence over the optional activities. Once a land area is classified as an eligible KP activity, all emissions and removals from that land must continue to be accounted thereafter.

Afforestation is defined as the conversion to 'forest' of land that has been non-forested for at least 50 years at the time of conversion, while reforestation is defined as conversion to 'forest' of land that has been non-forested for a shorter period of time (UNFCCC 2008b, p.90); otherwise, they are identical and hence generically termed Afforestation/Reforestation (AR). Conversely, deforestation (D) means the conversion of forested land to a non-forested state. In all cases, what is relevant is the change in land use since 31 December 1989. In other words, afforestation and reforestation may only be counted on land that did *not* meet the definition of 'forest' on 31 December 1989, while any land that *did* meet that definition then, and subsequently fails to meet it, is classed as deforestation. Temporary de-stocking, whether due to natural causes such as forest fire or human interventions such as harvesting, is not classed as deforestation as long as the land is expected to revert to forest.

The technical scope of each of the above activities is heavily influenced by the definition of 'forest'. Countries are allowed some discretion in this, and the UK has determined that in the national context for the first KP commitment period a forest is defined as a minimum area of 0.1 hectares with a minimum width of 20 metres; tree crown cover of at least 20%, or the potential to achieve it; and a minimum height of 2 metres, or the potential to achieve it (Defra 2006).

'Forest management' under the KP definition involves sustainable stewardship and use of both natural and plantation forests. In practice, this means forests that were established pre-1990, as any later forests would be counted (mandatorily) as AR. However, the scope for crediting removals of carbon dioxide through forest management is capped for the first commitment period in various ways; for the UK, it is limited to 1.36 $MtCO_2e$ per year, or 6.78 $MtCO_2e$ in total over 2008-2012 (Defra 2006).

Under the KP, emissions of six GHGs are reported – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).[75] The emissions of each are calculated using reporting guidelines

[75] From 1 January 2013, emissions of nitrogen trifluoride (NF_3) are also included, for the second commitment period to 2020 (UNFCCC Decision 1/CMP.8).

produced by the Intergovernmental Panel on Climate Change (IPCC), which also apply to UNFCCC reporting (IPCC 1997c). A reconciliation is then made of actual emissions versus the country's holdings of emission rights or 'Kyoto units', which are created as follows.

Developed countries which have ratified the Kyoto Protocol each have a target inscribed in Annex B to the Protocol, in the form of a percentage of 'base year' (usually 1990) emissions which must be achieved, on average, initially over the period 2008-2012 (first commitment period), and more recently, a second commitment period of 2013-2020. The EU's target for the first commitment period is 92% of 1990 levels (or an 8% reduction). This is converted into a fixed number of 'Assigned Amount Units' (AAUs) by multiplying the target percentage by the base year emissions (in tonnes of carbon dioxide equivalent, tCO_2e) and then multiplying again by five (for the years 2008-2012). If a country's actual emissions over 2008-2012 exceed its AAUs, it will be in breach of its KP target and face a compliance procedure, unless it has obtained a sufficient amount of extra eligible units to bring its account into balance. Eligible units include:

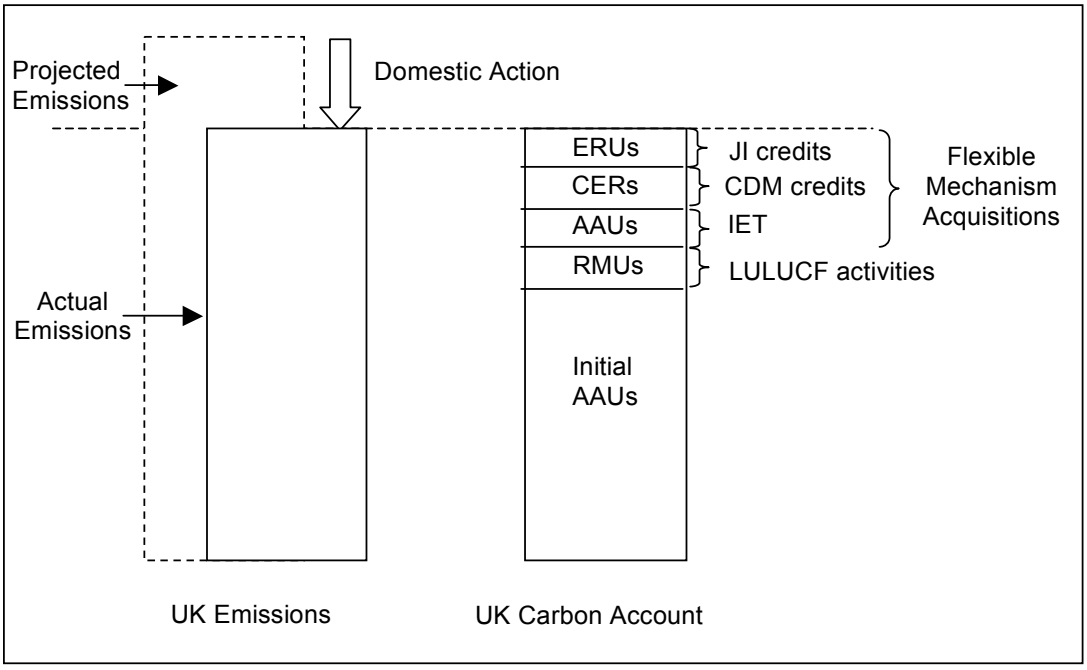
- AAUs obtained from another country (under 'International Emissions Trading');
- 'Emission Reduction Units' (ERUs) from emission reductions at a project level in another developed country (under 'Joint Implementation or JI);
- 'Certified Emission Reductions' (CERs) from emission reductions at a project level in a developing country (under the 'Clean Development Mechanism or CDM); and
- 'Removal Units' (RMUs) from net removals from LULUCF activities within the country, or obtained from another country.

The European Union (EU) has agreed to fulfil its commitments under the KP jointly. Under the so-called 'Burden Sharing Agreement', the EU's overall 8% reduction target was shared out between countries, with the UK adopting a 12.5% reduction target, whereas some other countries were allowed to increase emissions. Therefore the UK's Assigned Amount for 2008-2012 is equal to 1990 emissions of 779,904,144 tCO_2e x 87.5% x 5 = **3,412,080,630** AAUs (Defra 2006). This quantity is fixed according to the UK's 'Initial Report' under the Kyoto Protocol (Defra 2006), despite the fact that estimated 1990 emissions may be revised over time (for an example of a recent revision, see Webb et al. [2013]).

In theory, any new area of forest in the UK, as long as it meets the UK's definition of 'forest', is captured by national greenhouse gas accounting procedures. Statistics on forested

land are collected annually by the Forestry Commission, based on data collected for state-owned forests and from grant schemes for non-state-owned forests, and a "carbon accounting model, C-Flow, is used to estimate the net change in pools of carbon in living biomass, litter and soil in conifer and broadleaved forests" (Webb et al. 2013, p.494). Cumulative net gains in these pools of carbon, for forests planted since 1 January 1990 only, will eventually accrue to the UK's Kyoto Protocol account as RMUs (for the first commitment period, i.e. for cumulative net changes in AR up to 31 December 2012, this will only occur some time in 2015, after a 'review and compliance' period). Deforestation of pre-1990 forests is treated as emissions and added to the total of the UK's emissions from other sectors, while a reversal of a previously recognised removal (for example, if a newly planted forest is destroyed by fire) is netted off cumulative removals, or, if it exceeds cumulative removals, the Party must cancel other Kyoto units to remain within its cap. Figure 18 illustrates how the Kyoto Protocol requires commensuration of emissions and emission rights in order to be in compliance. Likewise, there is assumed commensuration or fungibility between different kinds of emission rights or Kyoto units.

Figure 18: Kyoto Protocol accounting: equating emissions with emission rights

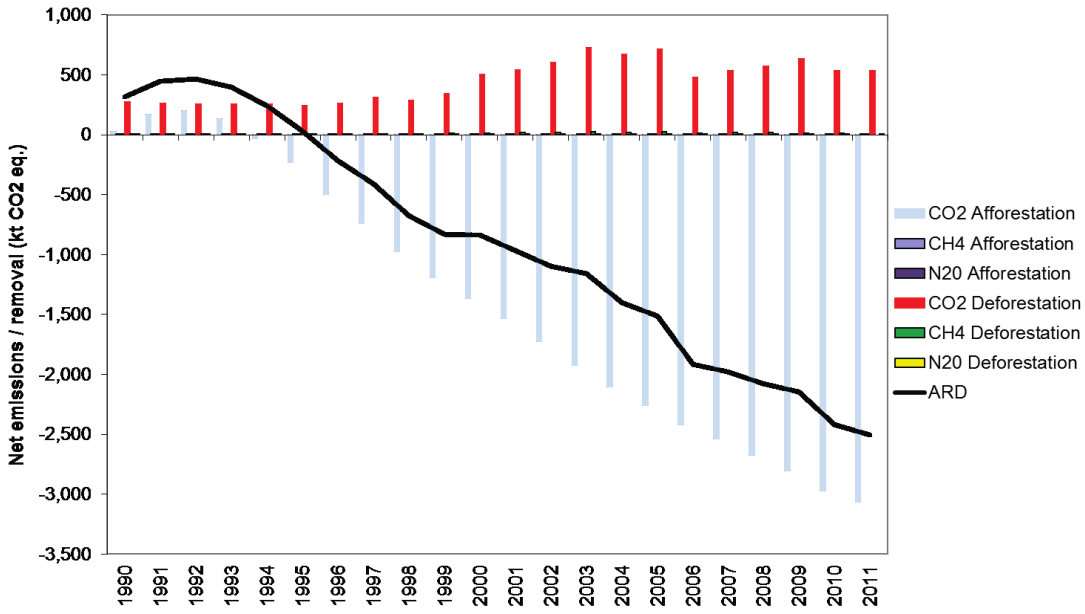


Source: (Defra 2008, p.3).

The black ARD line in Figure 19 shows the latest estimates for the amount of RMUs that will accrue to the UK's account in 2015 (the area above the curve, for years 2008-2011). If we extrapolate this forward to include 2012, we can expect around **11,500,000** RMUs to be

added to the UK's national account from net ARD, plus a further **6,783,333** RMUs from forest management (the actual amount of carbon stored will be around 42 $MtCO_2e$, but the amount that can be claimed by the UK is capped at 6.783 $MtCO_2e$). The total of around **18,283,333** RMUs is a little over 0.5% of the UK's overall cap (AAUs). This may seem relatively small, but it is not insignificant in absolute terms. To put it in context, the UK's second-largest coal-fired power station, Longannet (2.3GW), emitted roughly half this amount or 9,116,373 tCO_2 in 2012.[76]

Figure 19: UK emissions and removals from afforestation, reforestation and deforestation (Kyoto Protocol accounting)



Source: Webb et al. (2013, p.95).

The irony is that these RMUs are actually surplus to the UK's requirements under the Kyoto Protocol, yet the fact of their existence prevents UK forest owners from claiming the removals from their forests, due to the 'double-counting' provisions in most relevant carbon offsetting standards.

Figure 20 shows how the UK measures its performance against its Kyoto Protocol and Climate Change Act targets. Note that it is not shown to scale and most amounts shown are estimates; they are also totals for a five-year period (2008-2012) rather than annual figures. Columns 1 and 2 represent the UK's likely holdings of Kyoto units at the end of this period.

[76] Data from Sandbag, http://www.sandbag.org.uk/maps/emissionsmap (accessed 6 January 2014).

These comprise the UK's initial Assigned Amount (3,412 million AAUs, column 1), plus RMUs originating from the UK (column 2) – which in practice will only appear in the UK account in 2015. The total 'allowed' emissions for the UK under the Kyoto Protocol is the sum of these holdings of Kyoto units, or around 3,430 MtCO2e. In addition, the UK could have purchased Kyoto units (AAUs, CERs, ERUs or RMUs) from other countries, or sold Kyoto units to other countries, which would result in further additions or subtractions to the total holding of Kyoto units. However, the UK Government does not plan to make use of such options in the first commitment period (European Environment Agency 2013, p.79).

Column 3 then represents the UK's gross and net emissions, as measured under the Kyoto Protocol. Compliance with a country's target under the Kyoto Protocol requires the retirement of Kyoto units equal to the reported emissions for all sectors *excluding* LULUCF (i.e. KP gross emissions, or around 3,003.8 $MtCO_2e$). Net emissions or removals from LULUCF are reported separately; if the result is net emissions then additional Kyoto units must be retired against those emissions, but when the result is net removals this is credited as RMUs (column 2), which can then be used for compliance.

The UK's national carbon accounting is complicated by the participation of many large emitters in the EU ETS. The UK has fixed the 'allowed' emissions for its EU ETS participants (also known as the 'traded sector') via a National Allocation Plan setting out the total quantity of EU Allowances (EUAs) to be given away for free, auctioned or held back in various reserves over the 2008-2012 period (known as Phase II of the EU ETS) and separately for 2013-2020 (Phase III). In effect, under the EU ETS, a fixed amount of the UK's AAUs has been converted to EUAs and made available to the market. If UK participants in the EU ETS wish to increase emissions above this cap, they must purchase EUAs or other eligible (Kyoto) units from participants in other countries. These would then be accounted at the national level as units from another country, after the EU ETS participants have surrendered them to the UK Government for EU ETS compliance. On the other hand, if UK participants in the EU ETS reduce their emissions below the cap, surplus units could either be sold to participants from other countries, or banked for future compliance. These allowances are therefore accounted at the national level as a disposal of Kyoto units. Whether the surplus EU allowances are sold to EU ETS participants in another country, or if they are banked, they represent emissions that *will occur*, either in another country or at a future time. In other words, the contribution of the EU ETS to both the UK's Kyoto Protocol target and to the UK carbon budget is fixed at the level of the cap on UK

participants in the scheme (i.e. the number of UK AAUs initially converted to EUAs and made available to the market), regardless of actual performance. This makes sense because under the EU ETS, any extra emission in one place is compensated by a reduction in another place, and vice versa (although the compensation may occur at a different point in time).

The UK (see DECC 2014) reports its gross and net emissions with and without an EU ETS adjustment (illustrated in column 4). UK participants in the EU ETS have reduced their emissions over the 2008-2012 period 36.7 $MtCO_2e$ below their cap. Although these emissions have not occurred in the UK, the UK is obliged to transfer an equivalent number of Kyoto units (shown in the top blue rectangle in column 5) to other countries which have increased their emissions above their caps, which reduces the UK's overall surplus of Kyoto units (column 6).

After this, the UK's remaining Kyoto liability is equal to its 2008-2012 KP gross emissions, against which it must retire an equivalent quantity of Kyoto units. RMUs cannot be carried forward into subsequent commitment periods, so they will be used first. CERs, ERUs and AAUs can all be carried forward, although with certain limitations in the case of CERs and ERUs (UNFCCC 2008b; Arvanitakis et al. 2012). The UK is coy about stating its expected Kyoto surplus (DECC 2013b; DECC 2014); however, based on currently available statistics, I calculate that the UK will have a surplus of around 390 million Kyoto units at the end of the first commitment period (CP1), shown in column 6.

In addition to having these obligations under the Kyoto Protocol (or more precisely, the EU Burden Sharing Agreement that distributes the EU's Kyoto Protocol obligations between EU Member States), the UK has its own domestic legally binding emission reduction targets, under the Climate Change Act 2008. These are expressed as a series of five-year 'carbon budgets', with the first budgetary period corresponding to CP1 of the Kyoto Protocol. The UK's carbon budget for 2008-2012 has been set at **3,018,000,000 tCO_2e** (the blue part of column 7). However, it is measured in a different way to the Kyoto Protocol target. The starting point is the UK's *net* emissions as reported under the UNFCCC (column 8), rather than as reported under the Kyoto Protocol. This differs primarily with respect to the measurement of LULUCF (a further slight difference has to do with the scope of reporting under the Climate Change Act being limited to the UK and its Crown Dependencies [Jersey, Guernsey and the Isle of Man], whereas the Kyoto Protocol scope also includes overseas territories such as Bermuda, the Falkland Islands and Gibraltar – DECC [2014]). Although

the limited scope of KP LULUCF accounting is a sub-set of UNFCCC LULUCF accounting, the quantity of net emissions or removals could be greater or lesser, as it depends on the sum of a number of separate quantities, each of which could be net positive (emissions) or negative (removals). Presently available data on both sets of accounts suggests that UNFCCC LULUCF is a net sink of around 35.8 $MtCO_2e$, compared with only 18.2 $MtCO_2e$ recognised under the Kyoto Protocol. Therefore the UK's net emissions under the Climate Change Act are lower than they are under the Kyoto Protocol.

The UK's net UNFCCC emissions figure is then adjusted in a number of ways which are set out in the Carbon Accounting Regulations 2009 (HM Government 2009a) in order to arrive at a figure for the 'net UK carbon account' (column 11). Essentially, the UK's liability (in the form of emissions as accounted under the UNFCCC) is decreased by credits to the UK and increased by debits to the UK. Credits to the UK are carbon units which could be purchased by the UK Government specifically to reduce its liability under the Climate Change Act and may include AAUs, CERs, ERUs, RMUs (from a country other than the UK) or EU Allowances (EUAs) issued under the EU ETS. The Climate Change Act 2008 (2050 Target, Credit Limit and Definitions) Order 2009 (HM Government 2009b) specifies that the amount of such credits in the first budget period shall be zero, while the Climate Change Act 2008 (Credit Limit) Order 2011 (HM Government 2011) allows up to 55 million credits to be used in the second budget period, 2013-2017. Note that any such credits (shown in column 9) would only count for the purpose of compliance with the Climate Change Act, and could not also count towards compliance with the Kyoto Protocol (to ensure this, they go into a special account which is later cancelled).

A second adjustment, which may involve either credits or debits, is made in recognition of the operation of the EU ETS (column 10). It represents the same quantity as column 4 and for 2008-2012 effectively increases the UK's accounted emissions by 36.7 $MtCO_2e$.

If the net UK carbon account (column 11) is greater than the carbon budget (the blue part of column 7), section 17 of the Act allows up to 1% of the subsequent budget to be 'borrowed', or subtracted from the subsequent budget and added to the current budget. If the net UK carbon account still exceeds the budget, then the Minister of State is obliged to explain this to Parliament and to put forward proposals and policies to compensate for the budget excess (section 19). If, however, the net UK carbon account is lower than the carbon budget, the

difference may be carried forward and added to the budget of the subsequent period. For the 2008-2012 budget, a surplus of 36.3 $MtCO_2e$ is currently expected (DECC 2014).

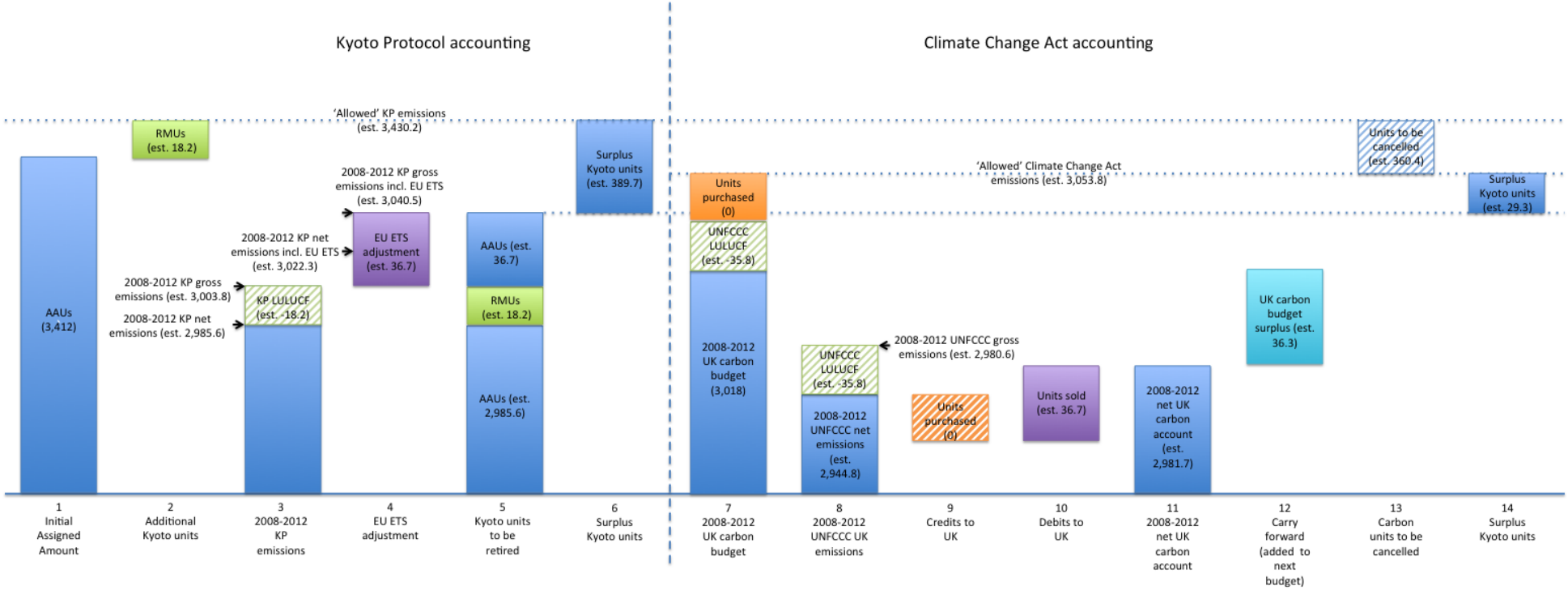
It is important to note that this surplus is not in the form of carbon units – it is simply a number, which is added to the subsequent budget. Surplus EUAs which have been 'banked' by private companies under the EU ETS would already be recognised in the 'debits' adjustment (column 10). Column 6, however, represents an actual surplus of Kyoto units held by the UK Government. If nothing was done about this, these units could be used as 'credits' (column 9) in the subsequent period, or they could be sold to other countries to offset their emissions. This would negate the intent of the UK's stricter carbon budget under the Climate Change Act. Therefore regulation 8 of the Carbon Accounting Regulations 2009 specifies that the UK must cancel surplus carbon units corresponding to the difference between its Assigned Amount[77] and the carbon budget, adjusted for credits (column 9) and also for the difference between Kyoto Protocol and UNFCCC accounting for LULUCF (the green part of column 8 minus the green part of column 3). Another way of thinking about this is that it is equivalent to the difference between 'allowed' UK emissions under the Kyoto Protocol (which includes net KP LULUCF) and 'allowed' emissions under the Climate Change Act (which includes net UNFCCC LULUCF plus any credits purchased specifically for compliance with the Act) – this is shown in column 13. Based on current data, there would appear to be a small surplus of Kyoto units (which I calculate as 29.3 16 $MtCO_2e$, column 14) which may still be carried forward, resulting in part from the different geographical coverage of the KP and Climate Change Act (16 $MtCO_2e$) plus the difference (13.3 $MtCO_2e$) between 'allowed' emissions under the Climate Change Act and actual net KP liability (which we might consider genuine over-achievement).

In summary, while UK forests undoubtedly make a contribution to the UK's national carbon accounts under both the KP and Climate Change Act frameworks, implicitly offsetting a quantity of emissions (18.2 $MtCO_2e$ under KP accounting over 2008-2012) equivalent to two years' emissions from the UK's second-largest coal-fired power station, the UK will end up cancelling nearly 20 times that number of Kyoto units as a result of its stricter self-imposed targets under the Climate Change Act. In effect, the 2008-2012 forestry RMUs are

[77] Technically, not its entire KP Assigned Amount (3,412 $MtCO_2e$) but 16 $MtCO_2e$ less (3,396 $MtCO_2e$ – DECC 2013a, p.23) corresponding to the narrower geographical scope of the Climate Change Act and known as the 'relevant share of the UK assigned amount' (HM Government 2009a). Thus the quantity shown in column 13 is 16 $MtCO_2e$ less than what the difference between the two dotted lines would suggest.

surplus to the UK Government's requirements. However, the complexity of the overlapping accounting frameworks is such that this conclusion is not immediately obvious to any but perhaps those officials and a few experts closest to the matter. This complexity may well constitute an unanticipated barrier to change in its own right.

Figure 20: UK carbon accounting under the Kyoto Protocol and Climate Change Act 2008



Source: Created by the author from data provided in DECC (2013; 2014). Note that the bars are indicative and not shown to scale.