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Transposing lessons between different forms of consequential greenhouse gas accounting: lessons for consequential life cycle assessment, project-level accounting, and policy-level accounting

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ABSTRACT

Greenhouse gas accounting has developed in a number of semi-isolated fields of practice and there appears to be considerable opportunity for transposing methodological innovations and lessons between these different fields. This research paper identifies three consequential forms of greenhouse gas accounting: consequential life cycle assessment; project-level accounting; and policy-level accounting. These methods are described in detail and then compared in order to identify the key methodological differences and the potential lessons that can be transposed between them. Analysis of the substantive methodological differences suggests that consequential life cycle assessment could be enhanced by adopting the same structure used in project and policy-level accounting, which provides a time-series of impacts, aggregate level analysis, and a transparent specification of the baseline and decision scenarios. There is a case for conceptualising a unified form of consequential time-series assessment, of which project, policy and product assessments would be sub-types.

1. Introduction

Greenhouse gas accounting has developed in a number of distinct fields of practice (Ascui and Lovell, 2011; Marland et al., 2013), and as a result there appears to be considerable potential for transposing conceptual or methodological innovations from one field of practice to others. Greenhouse gas accounting methods have developed at the national level (Penman et al., 2006), the organisational level (WBCSD/WRI, 2004), the product level (British Standards Institute, 2011; WBCSD/WRI, 2011b), the project level (ISO, 2006d; WBCSD/WRI, 2005), in addition to others. It may be assumed that when such methods have similar purposes but employ different methodological approaches, there is an opportunity for comparing those approaches and generating lessons for potential methodological development.

One grouping of methods, which forms the focus of this paper, is the set of greenhouse gas accounting methods that can be described as 'consequential' in nature. The term 'consequential' originates within the field of life cycle assessment (LCA) (Curran et al., 2005; Russell et al., 2005), but the concept can be used more broadly to denote any form of assessment which aims to quantify the total *change* in impacts that results from a given decision or intervention (Brander and Wylie, 2011). Consequential methods are often contrasted with 'attributional' methods (Reinhard and Zah, 2009; Tufvesson et al., 2013; Finnveden et al., 2009), which can be defined in a broad sense to denote any inventory of *absolute impacts* attributed to a given entity, such as a country, organisation, or product (Brander and Wylie, 2011; CDP, 2013), with attribution normally based on some form of physical connectedness. The focus of this paper is on the lessons that can be shared between different *consequential* methods, though some discussion of attributional methods will also be provided where this helps to explain certain features of the consequential approaches in question.

The novel contribution of this paper is the identification of *methodological* lessons that can be shared across different fields of greenhouse gas accounting practice. The academic literature on greenhouse gas accounting *methods* tends to exist within narrow communities of practice, such as the life cycle assessment community or the project accounting community, and there appears to be a significant lack of *methodological* dialogue between such fields. For example, the recent development of dynamic life cycle assessment (Beloin-Saint-Pierre et al., 2014; Collet et al., 2013) can

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be viewed as a reinvention of time-series assessment but without reference to, and some years after, project-level accounting. Greater awareness of the methodological innovations within other areas of practice may be fruitful in guiding and facilitating similar methodological developments. The existing literature that does take a more holistic view across different fields of greenhouse gas accounting practice has tended to take a social theory perspective, and considers issues such as the distinct social purposes of greenhouse gas accounting (Ascui and Lovell, 2011; Schaltegger and Csutora, 2012), or how accounting practices and competence are socially constructed (MacKenzie, 2009; Ascui and Lovell, 2012; Burritt and Tingey-Holyoak, 2012). However, as yet there is very little research on transposing methodological lessons, notwithstanding the *prima facie* likelihood that there is much to be learnt.

The primary contribution of this paper is the identification of methodological lessons that can be transposed between different forms of consequential greenhouse gas accounting, however, in pursuing this end the paper also provides some supplementary outputs: a classification of current greenhouse gas accounting methods according to whether they are consequential or attributional in nature; and a detailed discussion on the core and superficial methodological characteristics of the identified consequential methods. Although this paper is primarily focused on greenhouse gas accounting, the findings are relevant to consequential methods that consider other impact categories as well.

2. Methodology

This paper proceeds by identifying the existing forms of greenhouse gas accounting through a review of the current accounting standards and guidance, and classifies these methods as being either consequential or attributional in nature.

A list of published standards and guidance for physical greenhouse gas accounting was compiled based on existing knowledge of the main organisations publishing such guidance, such as the International Organization for Standardization, the Greenhouse Gas Protocol, and the Intergovernmental Panel on Climate Change, and also an internet search for 'greenhouse gas guidance', 'carbon guidance', 'GHG guidance' and 'LCA guidance'. An initial list of standards was compiled in early 2014, and was updated in early 2015 to achieve a more complete list at the time of publication. The list of standards collected is not intended to be exhaustive, and given the proliferation of standards and sector-specific guidance any list would become incomplete rapidly. However, the list of collected documents is sufficient for the present purpose of identifying the main consequential forms of greenhouse gas accounting and their methodological features.

Only standards and guidance for physical greenhouse gas accounting, as distinct from financial greenhouse gas accounting, were included as the purpose of financial accounting was considered sufficiently different that the transposition of methodological lessons would be unlikely. Physical greenhouse gas accounting is concerned with flows or changes in greenhouse gases in mass units, such as tonnes of CO_2e, while in contrast financial greenhouse gas accounting is concerned with the financial value of carbon-based assets and liabilities, such as tradable emission permits or reduction credits, measured in monetary units.

The collected standards were then classified as being either consequential or attributional in nature. The defining characteristics of consequential greenhouse gas accounting methods are taken to be: 1. the method aims to quantify *change* in emissions/removals, resulting from a decision or action; 2. the method aims to quantify *system-wide* change (i.e. not only change within a limited boundary). The criterion used to identify attributional methods is: the method aims to quantify and allocate absolute emissions/removals to a given entity or item. These defining characteristics are those identified in Brander and Ascui (2015), which collates a number of definitions for the 'consequential' and 'attributional' approaches in the LCA literature, and provides an analysis of the essential and supplementary features of the two types of approach.

As with many conceptual distinctions, there is ongoing debate as to its precise nature and implications (Suh and Yang, 2014; R. J. Plevin et al., 2014a; Brander and Ascui, 2015). Nevertheless, the nuances of that debate are sufficiently fine-grained that any alternative interpretations are highly unlikely to yield alternative classifications of the published greenhouse gas accounting standards. In the instances where classification did prove difficult, this tended to arise because the standard in question mixes both consequential and attributional elements, rather than because the classification criteria are unclear. It is worth noting that this situation can be distinguished from cases where the standard in question clearly intends to address both methods separately, within a single document (e.g. the ILCD handbook (European Commission et al., 2010)). The instances where classification was uncertain are discussed further in Section 3.1.

Some of the standards and guidance documents identified cover a wider range of impact categories than just greenhouse gas emissions, but were nevertheless included in the analysis if they covered greenhouse gas emissions as an impact category. The standards and guidance documents were then grouped by the type of entity or action they primarily relate to, e.g. national level, community level, product level etc. Table 1 in Section 3.1 presents the guidance and standards reviewed, and their categorisation by type.

The identified consequential methods are then described in detail, setting out the key steps and structure of each method. This information is then used to analyse any substantive differences between the methods and to identify the potential lessons for methodological development.

3. Results and discussion

This section presents the findings from the review and classification of existing greenhouse gas accounting methods, a detailed description of each of the consequential methods identified, and an analysis of the main methodological differences and potential lessons for the development of the methods.

3.1. Review and classification of existing greenhouse gas accounting methods

As noted above, there were a number of instances where it was more difficult to categorise a standard/guidance document as being either consequential or attributional, largely because the standard/guidance in question is ambiguous or mixes elements of both approaches in a single methodology. This is the case with the Greenhouse Gas Protocol's Product Life Cycle Accounting and Reporting Standard (WBCSD/WRI, 2011b), which explicitly states that it is intended as an attributional method but allows the use of substitution when dealing with multi-functionality, though substitution is generally regarded as a consequential modelling technique (Brander and Wylie, 2011). A similar issue arises with ISO 14040:2006 (ISO, 2006a) and ISO 14044:2006 (ISO, 2006b), though in these cases neither standard states whether it is intended to represent a consequential or attributional method, or both simultaneously. ISO 14040 uses the term "allocation procedures" which suggests an attributional method, though ISO 14044 allows both substitution and allocation. The failure of these standards to actually standardise practice is well noted by Weidema (Weidema, 2014), however, for the purposes of the current analysis these ISO standards have been classified as attributional as they contain no

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