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Carbon footprint using the Compound Method based on Financial Accounts. The case of the School of Forestry Engineering, Technical University of Madrid

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A B S T R A C T

Environmental information is required in order to make sustainable consumption decisions. Carbon Footprint offers a new scheme for reporting direct and indirect greenhouse gas emissions. The latest advances in Organization-Product-Based-Life-Cycle Assessment such as the Compound Method based on Financial Accounts provide an opportunity to work with easy-to-obtain data and to calculate both product Carbon Footprint and corporate Carbon Footprint. This work determines the Carbon Footprint of the School of Forestry Engineering (Technical University of Madrid) using this approach. It is designed to fulfill two objectives: (1) to evaluate Compound Method based on Financial Accounts as a tool for carbon footprinting; and (2) to provide an analytical basis for the implementation of carbon management plans. The total Carbon Footprint of the School of Forestry Engineering in 2010 was 2147 t CO_2eq, of which 59.0% corresponds to scope 3 emissions. Changes in consumption patterns are easier to capture due to the wide range of consumption categories considered with this approach. We conclude that Compound Method based on Financial Accounts is a practical method that correctly assesses the amount of direct and indirect greenhouse gas emissions. Calculation of Carbon Footprint using this method provides an analytical basis for the implementation of carbon management plans in university centers. This work has led to the integration of new schemes for sustainable development in the School of Forestry Engineering.

1. Introduction

Over the last century, the world population has quadrupled, and consumption of global resources has grown to a point where humanity now consumes resources at a faster pace than the Earth can regenerate (Wackernagel et al., 2002). One of the consequences is that world greenhouse gas (GHG) emissions grew by 29% in the period 1995–2007 (Arto et al., 2012). As a result, equivalent carbon dioxide (CO_2eq) emissions are accumulating in the atmosphere and causing changes in the climate, and potential negative feedback for the health of ecosystems (Butchart et al., 2010). National GHG inventories are built on the premise described by the IPCC (1996), and allocate only domestic GHG emissions, and thus emissions embedded in imports are not officially reported. Within this framework, several countries have reduced their domestic emissions, while world emissions continue to grow. New schemes are needed in order to implement all the available strategies.

Environmental information is required in order to make sustainable consumption decisions. In view of this, a new indicator, the Carbon Footprint (CF), has been developed over the last decade (Peters, 2010; Wiedmann and Minx, 2008). The goal of reducing CF could be a key factor for stimulating innovation while driving politicians to promote sustainable consumption. CF is an active research topic on which a large number of methodologies are currently underway in several countries (Peters, 2010; Wiedmann et al., 2011a). One of the main discrepancies in the approaches is the difference between product and corporate footprint (European Commission, 2010a, 2010b). To ensure the successful implementation of a CF indicator, a single cut-off criterion and data source are required in both approaches in order to enable comparability.

The Greenhouse Gas Protocol Corporate Standard (WRI and WBCSD, 2010) classifies emission sources around three 'scopes': Scope 1 is direct emissions that occur from sources that are owned

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or controlled by the organization, Scope 2 accounts for indirect emissions from the generation of purchased electricity, heat or steam consumed by the organization; Scope 3 is all other indirect emissions which are a consequence of the activities of the company, but occur from sources not owned or controlled by the organization. The focus when reporting GHG inventories is now shifting from direct emissions to the indirect emissions embodied in the upstream supply chain, and/or those caused by the use and disposal of products. The inclusion of these scope 3 emissions in GHG accounting highlights the need for a consumption-based approach (Larsen and Hertwich, 2009). Scope 3 emissions are particularly challenging to quantify, and a large number of sectors need to be analyzed in order to capture changes in consumption patterns. Downstream purchasing entities do not have access to detailed manufacturing information for each product purchased, nor the resources to investigate the supply chain of each product. Streamlined methods would therefore help to estimate scope 3 emissions (Thurston and Eckelman, 2011). The progress made in the methodology called Environmentally-Extended Multi-Region-Input-Output (EE-MRIO) analysis is among the most widely known (Minx et al., 2009). EE-MRIO analysis is an economy-wide, top–down approach that applies economic environmental accounting frameworks to map the structural components of direct and indirect demand for resources. An EE-MRIO analysis follows the flow of indirect emissions throughout the supply and production chains similar to the way in which an economic input–output model follows the flow of money or costs from production to consumption (Wiedmann, 2009). This approach allows the whole life-cycle impact of products and services to be captured across national and international supply chains.

The latest advances in EE-MRIO have been incorporated into new approaches for carbon footprinting. On the one hand, Environmental-Input-Output Life-Cycle-Analysis (EIO-LCA) is a hybrid approach in which life-cycle assessment methods derive primary data from bottom-up into top-down via EE-MRIO analysis. This method has been actively studied in both product-based (Wiedmann et al., 2011b) and corporate (Thurston and Eckelman, 2011) approaches. On the other hand, Organization-Product-Based-Life-Cycle Assessment is a top-down method in which EE-MRIO is used with easy-to-obtain data to calculate both product CF and corporate CF in a more comprehensive assessment (Cagiao et al., 2011; Carballo-Penela and Doménech, 2010). The Compound Method based on Financial Accounts (MC3, its Spanish acronym "*método compuesto de las cuentas contables*") (Doménech, 2007) belongs to this last type of approach, and is one of the most widely accepted methodologies in Spain (Cagiao et al., 2011; Carballo-Penela et al., 2009; Carballo-Penela, 2010; Carballo-Penela and Doménech, 2010; Doménech, 2007). This methodology is supported by the Technical Committee of the Carbonfeel Initiative (Carbonfeel, 2013), recognized by the Spanish Sustainability Observatory, and is approved as a valid approach for assessing corporate CF within the framework of the Spanish Voluntary GHG Reduction Agreement (De la Cruz-Leiva et al., 2011).

2. Higher education for sustainable development

The importance of integrating sustainability in educational and research programs has increased in recent decades (Stephens and Graham, 2010). Higher education centers strive to be exemplary institutions, as well as testing grounds for innovative climate responses (Wright, 2002). These efforts are fundamental in setting and tracking sustainability goals (Ferrer-Balas et al., 2010; Stephens et al., 2008). A considerable volume of literature has been published in specific conferences such as the Environmental Management Conferences for Sustainable Universities in the years 1999, 2002, 2004, 2006, 2008, 2010, and in the recent 2013 conference (Ciliz et al., 2013). Establishing a system that makes sustainable development an integral part of the university culture creates a multiplying effect within the institution and in society as a whole (Waheed et al., 2011). However, a large percentage of faculty leaders and members of higher education are unaware of these recent advances. There are few examples in which higher education institutions have made efforts to incorporate an environmental management system (Disterheft et al., 2012). Moreover, an effective and efficient implementation of sustainable development requires an overall paradigm shift in all the dimensions of a university system (Cortese, 2003; Lozano, 2006). A decision support tool might guide what actions should or should not be taken in order to achieve sustainable development goals.

Carbon and ecological footprints are indicators that can be monitored by organizations. Several works have been developed in recent years to evaluate these indicators in higher education institutions from United States (Klein-Banai et al., 2010; Klein-Banai and Theis, 2011; Thurston and Eckelman, 2011), from Europe (Larsen et al., 2013; Ozawa-Meida et al., 2013) and Australia (Baboulet and Lenzen, 2010). Moreover, outstanding initiatives are underway for GHG emission accounting in higher education: (1) Over 650 education institutions in the USA have developed GHG inventories and are about to take tangible actions (AASHE, 2012); and (2) the United Kingdom encourages higher education institutions to adopt reduction targets for their 2020 scope 1 and scope 2 emissions. Indirect emissions from procurement (scope 3) are not currently included in the reduction targets, although starting in 2012/13 higher education institutions will be required to report them, and eventually to set reduction targets by December 2013 (HEFCE, 2010).

This work aims to calculate the CF of the School of Forestry Engineering at the Technical University of Madrid using the MC3 approach. There are two objectives: (1) to evaluate MC3 as a tool for carbon footprinting; and (2) to provide an analytical basis for the implementation of carbon management plans. To our knowledge, this paper is the first CF analysis in higher education under the MC3 approach.

3. The School of Forestry Engineering

The School of Forestry Engineering at the Technical University of Madrid (henceforth "the Faculty") is located in the northwest of Madrid. It has approximately 1150 students and 235 staff (professors, researchers, administrative and service staff). Teaching and research activity is carried out by ten departments, six of which have their offices in the Faculty (Economics and Forest Management, Silviculture and Pasciculture, Projects and Rural Planning, Forestry Engineering, Linguistics and Mathematics). It stands on a campus of 9.7 ha, divided into forest (4.8 ha) and built-up land (4.9 ha). The operational boundaries of the study are determined by all the activities controlled by the Faculty. Therefore certain research programs funded by other institutions, split departments with no offices at the Faculty, the dean's office, cafeteria and restaurant service have not been considered, as they are not run by the Faculty itself. Nor have we considered the GHG emissions from staff and student commuting.

The operational expenses and investments for the year 2010 under study are 767,391 euros (€). The activity can be divided into two management areas: (a) Faculty offices (henceforth "the Offices") with expenses of €682,986; and (b) Departments with expenses of €84,405. Detailed financial data were obtained from the different units responsible. In many cases it was necessary to