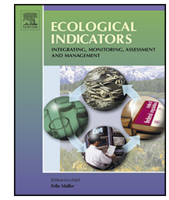
Ecological Indicators 49 (2014) 88–94

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



Compound method based on financial accounts versus process-based analysis in product carbon footprint: A comparison using wood pallets

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ARTICLE INFO

Article history:
Received 7 July 2014
Received in revised form 22 September 2014
Accepted 5 October 2014

Keywords:
Hybrid analysis
Hybrid method
Input–output analysis
MC3
LCA

ABSTRACT

Differences between product and corporate carbon footprint seriously hinder its wider implementation. The compound method based on financial accounts is a tiered hybrid analysis developed from advances in ecological footprint which main strength is its capability to calculate both product and corporate carbon footprint in a comprehensive assessment. This work aims to evaluate the compound method based on financial accounts as a tool for product carbon footprint. The objective is twofold: (1) to assess its advantages and disadvantages for product carbon footprint; and (2) to evaluate differences with process-based analysis. EUR-flat wood pallet is selected as the unit of study in a cradle-to-gate life-cycle perspective. Due to method requirements, a Spanish pallet manufacturer that produces and markets 1.6 million EUR-flat wood pallets annually has been selected for an in-depth assessment. Our life-cycle implementation reveals the following findings: (1) emissions from the compound method based on financial accounts are 22% higher than ones from process-based analysis, (2) process-based analysis provides greater detail in first life cycle phases than the compound method based on financial accounts, and (3) calculation time is drastically reduced using the compound method based on financial accounts. This study shows the compound method based on financial accounts as providing a correct assessment of the amount of direct and indirect emissions with easy-to-obtain data. Calculation time is drastically reduced, making it applicable to all shapes and sizes of businesses. It could, therefore, improve the CF in both approaches (product and corporate), stimulating innovation and increasing support for sustainable consumption decisions. Process-based analysis, in contrast, is not so easily implemented due to the large number of units involved in the upstream supply chain, and the use of thresholds hinders comparison. Even with these advantages, MC3 should consider other areas for improvement.

1. Introduction

Human-induced climate change is now recognized as the greatest environmental threat of the 21st century. Climate forecasts issued by the Intergovernmental Panel on Climate Change (IPCC, 2013, 2007) have led to several initiatives designed to achieve regional, national, and international agreements. These include particularly footprint family indicators, defined as a set of consumption-based indicators to account for environmental burdens imposed by human society on the environment (Fang et al., 2014).

Carbon footprint (CF) is a sustainable development indicator (Hoesly et al., 2012; Peters, 2010; Wiedmann and Minx, 2008) for measuring both direct and indirect greenhouse gas emissions (GHG) produced by a specific activity. A number of approaches are currently in use (Wiedmann et al., 2011a). The goal of reducing CF can be a key factor in promoting sustainable consumption decisions. However, the differences between product and corporate CF approaches (Ernst Young France and Quantis, 2010; Marsh-Patrick, 2010) seriously hinder their wider implementation. This dichotomy between corporate and product CF – i.e., ISO specifications for corporate and product CF (ISO, 2013a,b,b) – has not yet been resolved. One single approach to CF is needed in order to enable comparability and gain consumer confidence.

A corporate CF approach has been established under the schemes proposed for compiling an inventory of national GHG emissions (IPCC, 1996). These schemes are specified in the international standard ISO 14064-1, the GHG Protocol and the emissions trading directive, among other references (European Commission, 2004; ISO, 2006a; WRI and WBCSD, 2004). The product CF approach has been developed under the guidelines of life-cycle assessment (LCA). LCA is a bottom-up method that explores how the delivery of or demand for a specific product or

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http://dx.doi.org/10.1016/j.ecolind.2014.10.005
1470-160X/

service triggers processes that may cause environmental impacts. LCA seeks to give a complete picture of the environmental burdens caused by a particular product through a systematic mapping of operations and associated environmental pressures throughout a product's life cycle (ISO, 2006b).

There are two general methods for quantifying life-cycle emissions: (1) process-based analysis and (2) environmentally extended input–output analysis (EEIO). Process-based analysis assesses specific processes within the life-cycle operations, thereby, potentially generating results with high levels of detail and accuracy. On the downside, cut-off criteria are applied to exclude operations that are not expected to make significant contributions. Some authors have reported that process-based analysis fails to account for 30% or more of the total CF (Lenzen, 2000; Majeau-Bettez et al., 2011). EEIO, in contrast, is a top-down technique in which inventories are quantified using monetary data at a high aggregation level. EEIO does not require cut-off criteria, and therefore, does not involve the problems of process-based analysis with truncation. However, it is not detailed enough to support comprehensive sustainable consumption decisions. Hence hybrid methods can be seen as a solution to exploit the advantages of both approaches (Wiedmann et al., 2011b), although these methods have yet to become standard practice in LCA (Majeau-Bettez et al., 2011).

One of the most recent contributions to hybrid methods is the compound method based on financial accounts (MC3, from its Spanish acronym "Método Compuesto de las Cuentas Contables") (Doménech, 2007). This is a tiered hybrid analysis (Suh and Huppes, 2005) capable of calculating both product and corporate CF in a comprehensive assessment (Carballo-Penela and Doménech, 2010; Doménech, 2007). The method is one of the most widely accepted approaches in Spain, and was approved as a valid means of assessing corporate CF within the framework of the Spanish voluntary GHG reduction agreement (De la Cruz Leiva et al., 2011). It is also endorsed by the Spanish Technical Committee of the Carbonfeel initiative (Carbonfeel, 2014). Its advances have been the subject of previous studies (Alvarez et al., 2014; Cagiao et al., 2012, 2011; Carballo-Penela and Doménech, 2010; Carballo-Penela et al., 2009), although none assess the differences between MC3 and common methods for product CF.

Pallets are the most commonly-used unit-load platform, and allow the transportation of goods in an efficient and reliable way. World merchandise trade accounts for more than half the global economy, and has grown tenfold in the last 30 years (United Nations, 2014). In this increasingly globalized world, international companies are keen to have a thorough understanding of the environmental impact of their logistics operations, and pallets are an important part of these operations. Currently, 700 million new wood pallets are manufactured every year and become part of the large pool (roughly 2 billion) of pallets in circulation in the U.S. (Grande, 2008). Ninety percent of these wood pallets are used only a few times and go on to meet one of several end-of-life scenarios (e.g., landfill, municipal incineration or downcycling), while others are repaired and reused many times (Mazeika, 2011). Their environmental assessment is highly significant and depends on their materials, manufacturing, handling processes, and disposal practices. Numerous surveys have analyzed materials (Corbière-Nicollier et al., 2001; Emiliani and Stec, 2005; Ng et al., 2013; Singh and Walker, 1995), handling processes and disposal practices (Bilbao et al., 2011; Gasol et al., 2008; Mazeika, 2011; Sreenual et al., 2012), but few have focused on the details of the manufacturing stage (Abbott, 2008; Kellenberger et al., 2007; Ng et al., 2013).

This work aims to evaluate the MC3 approach as a tool for product CF. The objective is twofold: (1) to assess the potential of MC3 for product CF; and (2) to evaluate differences between MC3 and process-based analysis. The EUR-flat wood pallet (ISO, 2003) was selected as the unit of study in a cradle-to-gate life-cycle perspective (hereafter, partial CF – according to the ISO/TS 14067). This specific unit of study was selected due to fact that it is the widely-extended standard European pallet as specified by the European Pallet Association.

2. Materials and methods

2.1. Functional unit

The functional unit considered in the partial CF is a EUR-flat wood pallet with dimensions 1200 × 800 × 144 mm, located at the consumer site. This pallet – also known as Euro-pallet or

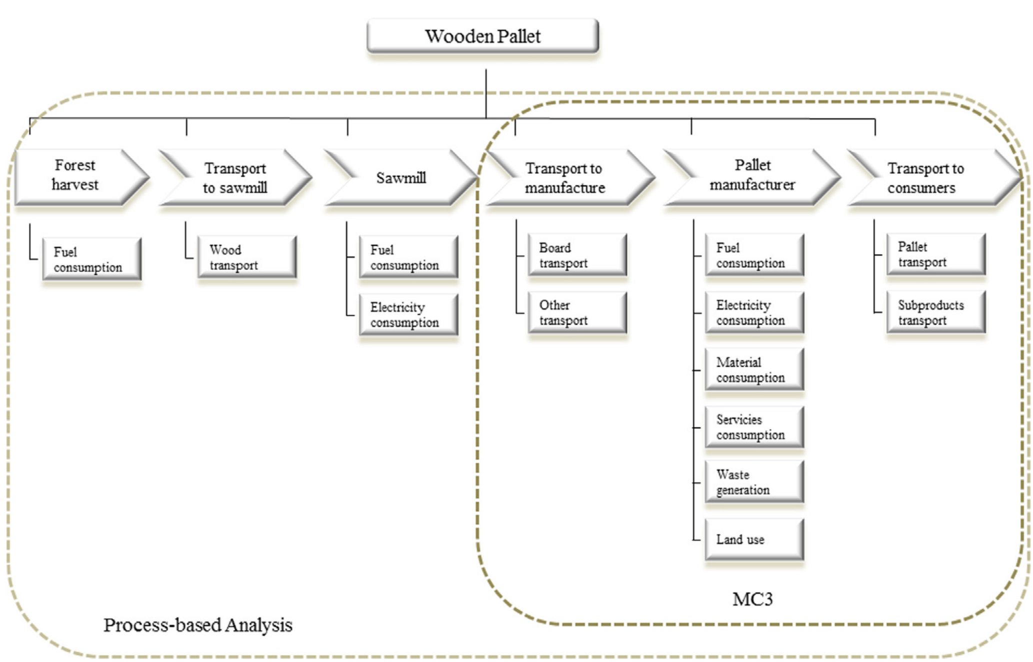

Fig. 1. Wood pallet life-cycle flow chart for the compound method based on financial accounts and process-based analysis.