KEY METHODOLOGICAL ASPECTS FOR THE ASSESSMENT OF SURFACE FREIGHT TRANSPORT ACTIVITIES IN A LCA ANALYSIS

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ABSTRACT

This paper reviews the most common methodological issues found in Life Cycle Assessment (LCA) studies associated with freight transport activities. Main conclusion drawn is that LCA is a suitable tool to assess the environmental impacts of freight transport activities, since other pollutants rather than CO_2 and other GHGs are produced, although carbon footprint can be applied in certain situations. A deep study on the pollutants produced in these activities revealed that a comprehensive analysis should be accompanied by a full set of impact categories. Infrastructure processes and land use should be included although it makes difficult the analysis. Furthermore empty backhaul trips and pre and post-positioning trips should be considered and attributed to the product transported in the fronthaul trips.

INTRODUCTION

Transport is of fundamental importance as it supports increasing mobility demands for passengers and freight (Rodrigue et al., 2009). Freight transport is essential to continued economic growth (BTS, 2010), but it is also one of the main sources of energy consumption and greenhouse gases emissions giving rise to significant air pollution, which can seriously damage man's health and ecosystems (EEA, 2003). Many studies have been carried out to evaluate the impacts that transport systems have on the environment (Eriksson et al., 1996; Johnsen and Fet, 1998; Stripple and Uppenberg, 2010).

Life cycle assessment (LCA) is one of the most widespread methods for assessing the environmental impacts of transport systems (Johnsen, 2000; Stripple and Uppenberg, 2010, Chester and Horvarth, 2010). However, difficulties are likely to occur in their evaluation. The aim of this paper is to provide some general guidelines to be applied when freight transport activities are evaluated using LCA perspective and to overcome methodological problems such as the selection of relevant impact categories for transport activities, the inclusion of infrastructure processes and backhaul trips and the integration of land use in a transport LCA. This study is focused on surface freight transport, excluding air freight since it represents only about 0.1% of freight transport and hardly competes with other modes as Den Boer et al. (2011) reviewed.

METHODS

A systematic literature review of environmental assessment studies about transport systems has been performed. Both ancient and recent studies have been considered in order to show how the evolution of the approaches with the development of powerful and comprehensive tools and databases. Four main methodological issues related to transport activities have been identified amongst more than twenty articles and standards. Each methodological aspect is discussed with regard to differences between studies and current LCA literature, followed by recommendations for each one.

RESULTS

As a result of the review of selected literature, several results were achieved with regard to methodological issues in the LCA of freight transport. A set of main impact categories have been suggested based both in the literature and the analysis of main pollutants in freight transport: climate change, photochemical oxidation, acidification, eutrophication, inorganic respiratory, human toxicity (carcinogens) and cumulative energy demand (CED). The review also confirms the relevance of infrastructure processes since may affect all impact categories. Furthermore a close relationship between infrastructures and land use impact category was observed. It was found out that empty backhaul trips, and specifically pre and post-positioning trips, had also effects on the environment and therefore they have to be accounted.

DISCUSSION

This section outlines four methodological aspects to support LCA practitioners to assess the environmental impacts due to freight transport activities.

Selection of impact categories for life cycle impact assessment

The main pollutants related to transport activities are CO_2, NO_x, SO_x, PM, CH_4, NMVOC and CO. LCA allows the selection and definition of the impact categories and the assignment of the each substance to the impact categories. Some of them contribute to only one impact category, so the assignment is straightforward. Other pollutants contribute to two or more different impact categories and the assignment depends on the interaction between them. Consequently, transport sector is an important source of pollutants, rather than only CO_2 emissions. Therefore, LCA methodology seems to be as the most suitable tool to address the environmental performance of freight transport instead of using only one indicator such as carbon footprint. In that sense, the use of LCA avoids disregard other relevant potential impacts of transport activities on the environment. However carbon footprint could be suitable in certain cases (ILCD Handbook, 2010).

Infrastructure processes

The different LCA studies reviewed show that capital goods are of fundamental importance when assessing environmental impacts of freight transport. The actual databases have already comprised data about infrastructure processes. Therefore, including infrastructure processes in LCA analysis seems an appropriate and unified approach for transport sector. Although including infrastructure processes is recommended, sometimes they may be omitted. For instance, when assessing carbon footprint of transport services since, as Frischknecht et al.

(2007) reported, capital goods contribute to climate change with only 18.1%. In these cases infrastructure processes may be neglected simplifying the calculations.

Backhaul trips

Life cycle in transport activities is subject, when multiple national and transnational production sites are involved, to a variety backhaul trips (Cooper et al., 2008) and other empty trips such as pre-positioning and post-positioning before and after loading the cargo (BSI Group, 2011). Little consistency has been found in backhaul assumptions used in LCA studies investigating specific transport systems (Cooper et al., 2008). When return trips are considered, a backhaul factor may be assumed referred to fronthaul or a specific load factor for the return trip may be applied. Moreover, empty trips depend on the type of goods transported. In general, it can be assumed that the transport of bulk goods, such as coal or oil, requires more empty trips than that of volume goods like for instance industrial parts or consumer goods (EcoTransit, 2011). The European Standard EN 16258 (2012) sets a general approach based on considering the empty trips, but also the pre-positioning and post-repositioning operations to load the vehicle. Both, pre-positioning and post-repositioning, according to this standard should be included within the vehicle operation. Consequently, following the approach set by the standards, it seems appropriate to attribute backhaul trips and pre-positioning and post-repositioning operations to the commodity transported when transport system are being studied with a LCA perspective.

Land use considerations

The review of previous studies reveals land use is an important intervention that has potential effects on the environment, especially the fragmentation of habitats. On the other hand, the closely relationship between land use impact category and capital goods has been demonstrated by some authors.

CONCLUSIONS

This paper suggests some guidelines to overcome with some common methodological issues that are usually facing LCA experts and practitioners: selection of impact categories, inclusion of infrastructure processes, procedures to deal with backhaul trips or land use implementation. In accordance with the findings of this review, it is clear that a comprehensive LCA analysis of freight transport should be accompanied by a full set of impact categories like: climate change, photochemical oxidation, acidification, eutrophication, inorganic respiratory, human toxicity (carcinogens), Cumulative Energy Demand (CED). Regarding infrastructure processes, the review reveals that they should be included when a LCA is being carried out since their construction involves a large amount of particulate matter emitted. Moreover, the studies point out that they have an important contribution to all impact categories, especially to land use and mineral resources consumption.

In accordance with the findings of this review article, backhaul trips and more specifically pre-positioning and post-repositioning operations have to be attributed to the product transported in the fronthaul trip.

On the other hand, the implementation of land use impact categories is still unclear. However, several authors recognize that it is closely related to infrastructure processes. The construction, maintenance or pre-combustion infrastructures can account for about 95% of the total land use in freight transport.

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