Ecological Modelling 221 (2010) 2215–2225

Contents lists available at ScienceDirect

Ecological Modelling

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

Assigning results of the Tool for Sustainability Impact Assessment (ToSIA) to products of a forest-wood-chain

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ARTICLE INFO

Article history:
Available online 21 April 2010

Keywords:
Allocation
Forestry
Impact assessment
Multi-output processes
Sustainability impacts
ToSIA

ABSTRACT

A Tool for Sustainability Impact Assessment (ToSIA) has been developed for assessing sustainability impacts of forest-wood-chains (FWCs). Sustainability is determined by analysing environmental, economic, and social sustainability indicators for all the production processes along the FWC. Results of the tool can be analysed at an aggregated level for complete FWCs, but for some applications it is useful to assign the indicator results to products of the chain.

This paper presents a procedure in ToSIA to assign sustainability impacts to multiple output products of FWC. The procedure was tested and demonstrated with an example FWC from Scandinavia that included furniture and bio-energy production. Two different allocation criteria, carbon-based and economic value-based, were applied with different options for assigning the impacts on the sub-products of the chain. Three indicators representing the three pillars of the sustainability were chosen to demonstrate the procedure: production costs (economic), employment (social) and transport intensity (environmental).

The results indicated that the allocation criteria greatly affect the indicator results assigned to the different products of FWCs. The selection of the allocation criterion depends on the question approached and on the availability of the needed process related data. The data availability is assured for the carbon-based allocation within ToSIA, as following the carbon flows within the chain is mandatory for any ToSIA application. Economic values of products, on the other hand, are more closely linked to the aims of the production processes of the value chains and are thereby meaningful allocation criteria in many cases. The allocation procedure of ToSIA was proved to be flexible allowing different criteria and still consistent in allocation of the various sustainability impacts of the FWCs.

1. Introduction

The European Union (EU) has established ambitious goals to develop a more sustainable society. It adopted a strategy for sustainable development (EC, 2001) in which it declared that all EU policies must have sustainable development as their core concern. Therefore, all major policy proposals should include an assessment of the potential economic, environmental and social benefits and costs of action or lack of action. This has consequently created a need for reliable and transparent ex-ante assessment of sustainability impacts of planned policies, and new integrated assessment methods and tools are being developed for different sectors (e.g. Helming et al., 2008; Ewert et al., 2009).

The forest-based sector makes a significant contribution to the European economy. The sector employs around 3.9 million people and the annual sales are on average 400 billion EUR (Blombäck et al., 2003). The challenge of measuring the sustainability impacts of the forest-based sector was tackled in the European-wide EFORWOOD project (www.eforwood.org), in which the Tool for Sustainability Impact Assessment (ToSIA) for complete forest-wood-chains (FWCs) was developed. The tool can be used to highlight changes in sustainability due to deliberate actions (e.g. in policies or business activities) or due to external forces (e.g. climate change, global markets). Impacts are calculated for various economic, social and environmental sustainability indicators that are linked to processes of the FWCs in a similar way as in Life Cycle Assessment (LCA) (ISO 14044, 2006). The tool was developed to be able to do wide-scale impact assessment analysis covering forest sector processes and products up to a continental scale. ToSIA integrates several different methods, and allows an overall sustainability impact assessment to be performed by further processing results with the incorporated multi-criteria analysis (MCA) (Mendoza and Martins, 2006) or cost–benefit analysis (CBA) (Nas, 1996) functionalities. A detailed description of the

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doi:10.1016/j.ecolmodel.2010.03.020

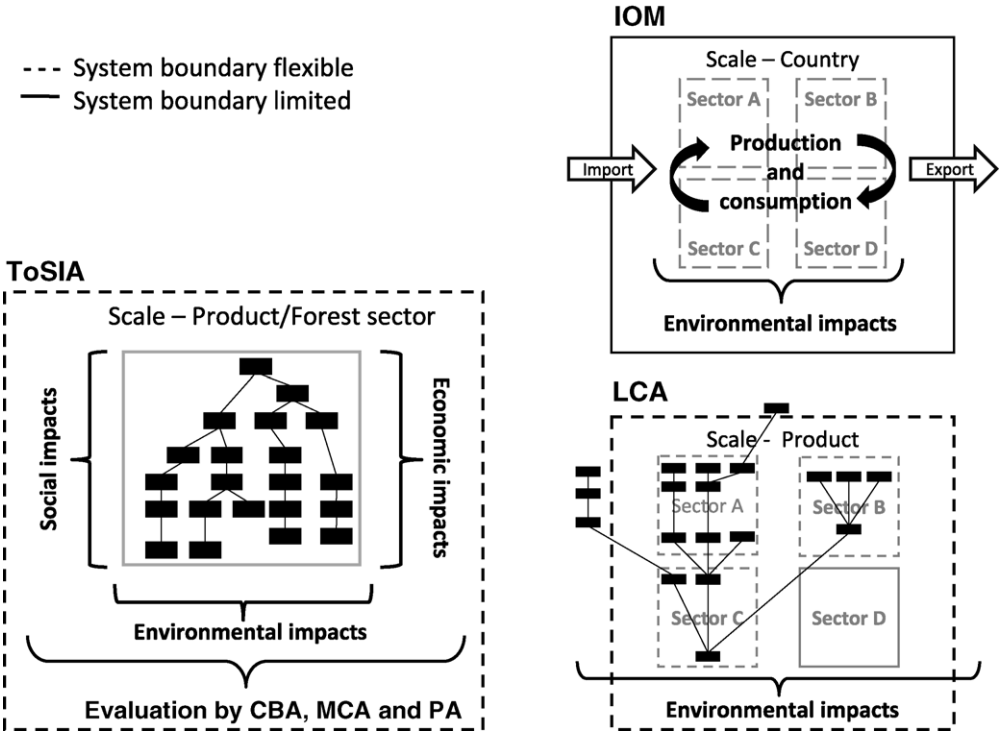

Fig. 1. Simplified illustration of the Tool for Sustainability Impact Assessment (ToSIA), input–output modelling (IOM) and environmental life cycle assessment (LCA). Big boxes represent geographical system boundaries (e.g. country) within which all studied impacts are to be covered. Small boxes represent production sectors. LCA follows singular production chains as far as possible, also over the country and sector borders. IOM links the environmental impacts to trade statistics. Sustainability impact assessment done by ToSIA concentrates on the forest-based sector and covers also social and economic impacts that can then be evaluated by cost–benefit analysis (CBA), multi-criteria analysis (MCA) or policy analysis (PA).

ToSIA approach is given in Lindner et al. (2010) in this special issue.

As ToSIA was developed to be a decision support tool, the main criteria for the ToSIA development were reliability, flexibility and transparency, the latter of which requires a certain level of simplicity from the methods used. Because the integrative nature of ToSIA was an important consideration, the tool was developed to be able to handle a large number of varying sustainability indicators at the same time and to be able to cover systems from single production chains up to the whole EU forest-based sector. These aspects differentiate ToSIA from the environmental product LCA (ISO 14044, 2006), in which the number of studied indicators at one time is typically narrower, but where the impacts of the production or changes in production are studied at a more detailed level including also the avoided impacts of alternative production. Whereas LCA or the related carbon or ecological footprint assessment (Wiedmann and Minx, 2007) focus on improving the environmental impacts of a product, ex-ante sustainability impact assessment as applied in ToSIA aims to evaluate the impacts of alternative policies or alternative production processes on sustainable development, considering the different dimensions of sustainability in a balanced way. FWCs studied in ToSIA do not currently cover processes from other industrial sectors whereas in LCA the production is followed as far as possible, also beyond sectoral borders (Fig. 1). This limitation of ToSIA is not, however, a conceptual decision, but is rather due to limited resources that required priority to be placed on the development of methods and collection of sustainability data for the forest-based sector in Europe. On the other hand, ToSIA is more detailed than environmentally extended input-output models (Turner et al., 2007; Wiedmann et al., 2007), in which the environmental impacts of production sectors are linked to compiled trade statistics of inter-sectoral or national level. The primary function of environmental input–output analysis is in a static ex-post accounting mode to quantify the inter-dependence of different activities and environmental loads within the economy (Fig. 1).

Production chains in the forest-based sector, as well as many of the processes of FWCs are multi-functional, i.e. they yield more than one functional product. For example, material flows from a harvest of one forest stand can lead to several products from high quality carpentry products to soft paper and from house construction materials to energy production. The issue of multi-functionality leads to the question of how the sustainability impacts of production chains should be divided among the multiple output products of chains. This problem is commonly called an allocation problem and has been widely discussed in the context of Life Cycle Inventories (LCI) (e.g. ISO 14044, 2006; Jungmeier et al., 2002a; Ekvall and Finnveden, 2001). It has been noticed that the choice of the allocation procedure has a notable impact on the results of these studies (see e.g. Guinee and Heijungs, 2007; Jungmeier et al., 2003). The International Organization for Standardization (ISO) has presented a standard for LCI (ISO 14044, 2006), that defines possible procedures for allocation.

The focus of ToSIA lies on sustainability impact analysis of changes to the FWC, rather than on assessing sustainability of individual FWCs (Lindner et al., 2010). The tool is therefore meant for effect-oriented sustainability assessments and it approaches this task in a descriptive way by facilitating the consistent data collection and analysis of FWCs to be compared. For example, the tool could be applied to study the impacts of policy actions taken to enhance the bio-energy production on the sustainability of the forestry sector at country level by comparing two alternative FWCs. Here, allocation serves the purpose of enabling comparisons of sustainability impacts between the alternative scenarios in relation to a common functional unit quantifying the output of the production systems in question (e.g. Schmidt et al., 2009). Allocation in these comparisons is applied separately for compared chains in order