Assessment of Sustainability of Forest-Wood Chains

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Table of contents

Abstract

Forest-Wood Chains (FWCs) consist of a set of processes by which forest resources are converted into services and products. In this paper, a method to assess sustainability of alternative FWCs is discussed. It is suggested that each production process included in a production chain will be characterised by a set of environmental, economic and social sustainability indicators. The volume of wood material flows through the processes is the basis for assessing the overall sustainability of optional chains.

Keywords: Sustainable development; environmental, social and economic sustainability; forest-wood chains; sustainability indicators

1. Background

Sustainability has been the leading principle in forestry for centuries. The goal of forest management has been to organise timber harvesting schedule according to the forest growth potential in order to maintain a continuous flow of timber production. In the 20th century, the multiple use of forest resources replaced the narrow focus on timber production that had dominated as a management goal earlier. Consequently, multi-dimensional aspects of sustainability were included in forest management.

At the global level, the Brundtland report (1987) brought forward the concept of sustainable development which means a development meeting the needs of the present without jeopardising the ability of future generations to meet their own needs. Since the Earth Summit in Rio de Janeiro in 1992 (UNCED), both forests and forestry have been added to the international agenda because of concerns about the sustainability of forests regarding biodiversity and its economic and social contribution to the development of the local communities.

As entering into the 21st century, the sustainability paradigm has been extended to include whole economic sectors. Not only the forest production but also the whole set of production chains using forest resources should be evaluated in sustainability impact assessments of Forest-Wood Chains (FWCs). Sustainability Assessment (SA) deals with influence of production technologies or other processes in the FWC on sustainable development, measured by using environmental, economic, and social indicators (see Wilhelmsson 2001). FWCs consist of sets of processes by which forestry resources are converted into services and products. A process is the basic element in the analysis of an

FWC. In a process the wood material changes its appearance and/or moves to another location. Processes include planting trees, tree growth, harvesting, transport, sawing, pulping, papermaking, printing, packaging, recycling, energy production etc.

The FWC consists of a number of processes which all will be characterised in terms of sustainability indicators. Based on the forestry statistics and production figures of the forest industries, most European countries have good information on the volumes of wood-material flow related to their FWCs. In Figure 1 an example is given from Finland (Finnish Statistical…. 2003). These statistics, however, only refer to production volumes and do not thus address the indicators of sustainability related to environmental, social or economic issues. However, these particular statistics, possibly converted to carbon flow volumes, could serve as a basis for sustainability assessment of forest-wood chain.

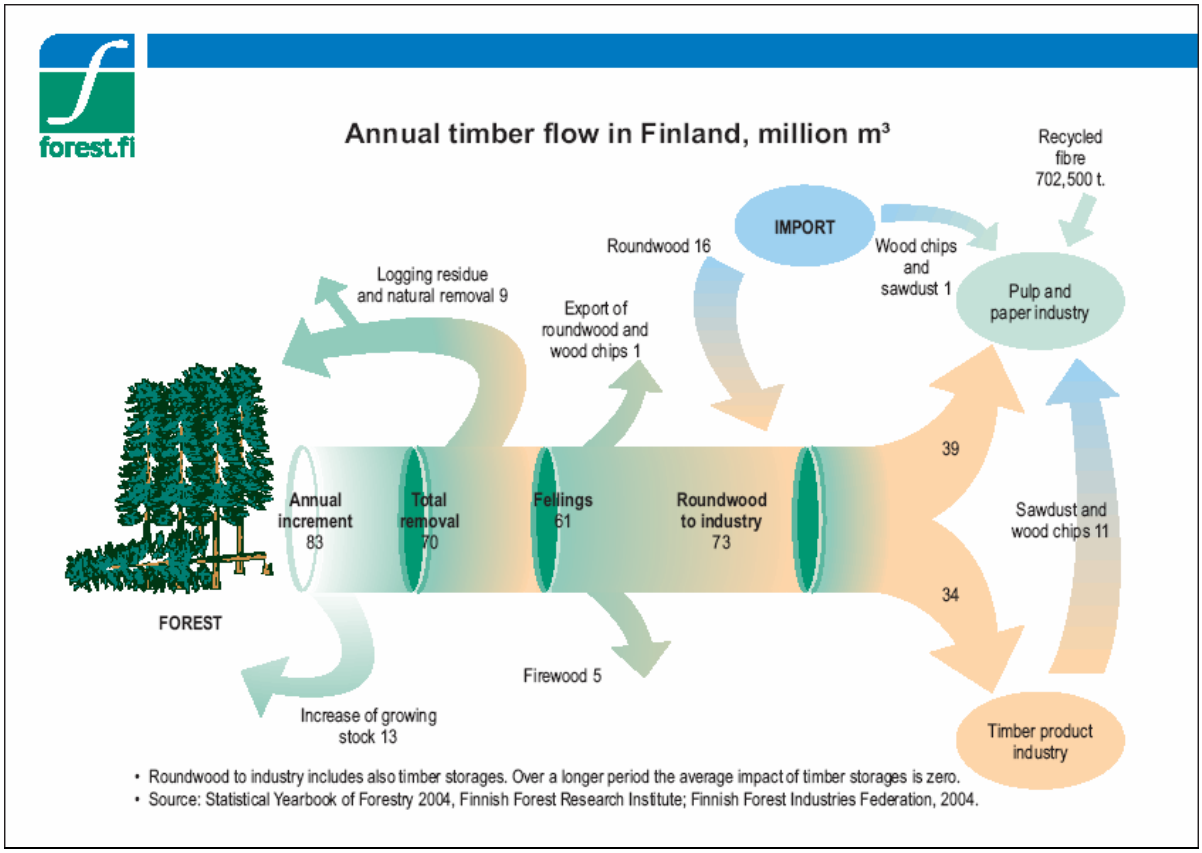


Figure 1. A simplified example of an FWC, the annual timber flow in Finland. Source: forest.fi (original source used by forest.fi: Statistical Year Book of Forestry 2004, Finnish Forest Research Institute; Finnish Forest Industries Federation)

Several methods have been developed to study environmental impacts of technologies, including also quantitative approaches such as Substance Flow Analysis or Life Cycle Assessment (LCA) (see Hytönen 1998).

For the FWC, a comprehensive Sustainability Assessment is still lacking, although the concepts and indicators for monitoring environmental, social, and economic sustainability are very well advanced in the forestry sector.

2. Sustainability indicators

Several international, regional and national processes and fora have resulted in criteria and indicators for sustainable forestry such as Ministerial Conferences on the Protection of Forests in Europe. (General declarations… 1998, Improved Pan-European Indicators for Sustainable Forest Management, 2003). There are ongoing efforts aiming at consolidation of the various developed criteria and indicators (Hecker et al. 1998).

Since the late 1990s, the EUROSTAT and the European Environment Agency have developed sustainability indicators within the framework of the EU strategy for sustainable development, the Sixth Environment Action Programme, and the Cardiff Process on integrating environmental considerations in EC policies. Sustainability indicators have also been adopted in the Sustainability Impact Assessment (SIA) of the World Trade Organisation negotiations. In the SIA of trade policies, various impacts based on the three sustainability principles have been listed e.g. by affected country or group of countries, or by product (see Zhu et al. 1998; Kangas and Baudin 2003; Vasara et al. 2005).

Thus far there has been no attempt to analyse trade-offs between or to study impacts systematically along the entire FWC. The multifunctionality of forests and the sustainability of the whole FWC should be addressed by analysing and selecting sustainability indicators which reflect the multiple benefits of forest resources and all three pillars of sustainability.

The domains of the sustainability of the FWC may include as examples:

- *Environmental*: biodiversity, carbon sequestration, soil fertility, pollutants and wastes, water quality, energy efficiency in production, water use efficiency, change of natural resource stock and degree of recycling,
- *Societal:* employment, consumers' requirements and expectations for products and services, cultural values, recreational possibilities, rural development, human health and well-being,

- *Economic*: competitiveness, value-adding, development of existing and new markets, real income, investment capital formation, cost-benefit, energy use and production.

Some of the indicators may be relevant and used to assess processes throughout whole chains, e.g. carbon stocks and flows in the system, fossil fuels and energy balance, return or cost of capital, salaries, taxes or employment. Some others are clearly associated with only parts of the chain, such as biodiversity or recreation in forests, or water pollution in industrial manufacturing.

The purpose of this paper is to suggest a methodology for assessing the sustainability of the whole Forest-Wood Chain.

3. A method to assess sustainability

The proposed Sustainability Assessment of the FWC integrates outputs from different processes. The method will simulate FWCs as chains of value-adding production processes. The boxes in Figure 2 represent processes at various stages of the chain. The chain of arrows in Figure 2 represents one possible FWC. Although in real life the material flows in an FWC are more complex than the ones presented in Figure 2.

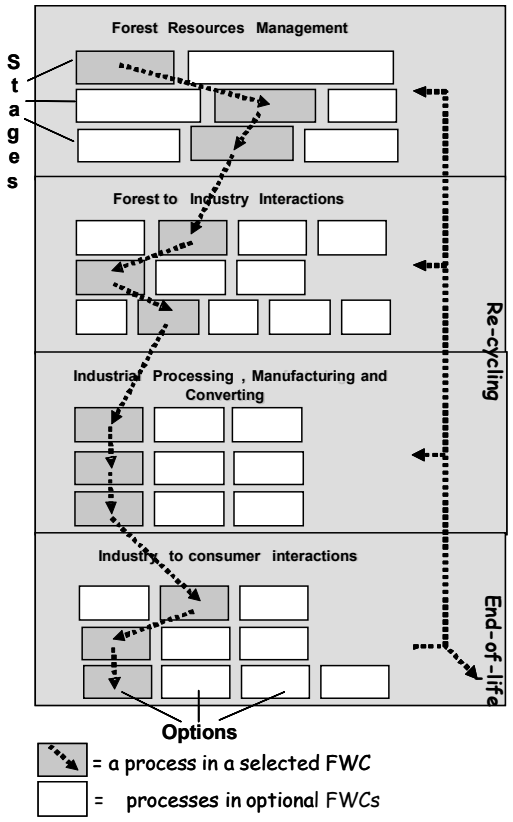


Figure 2. The methodological framework to assess the sustainability of FWCs. The shaded boxes represent processes in one FWC.

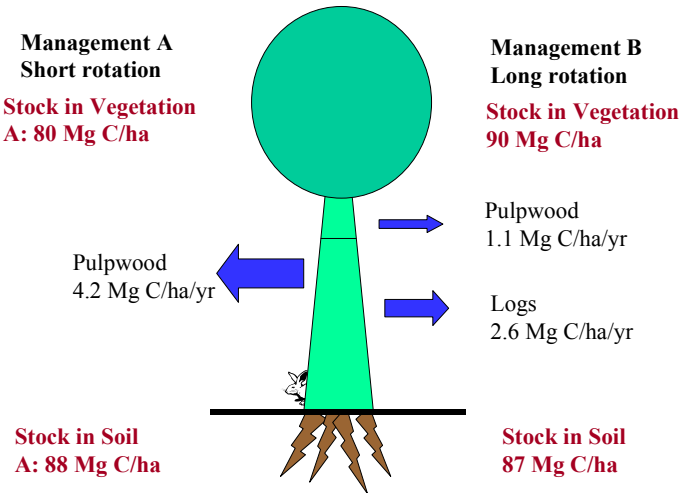
The flow of wood is followed through production processes from forest to consumption and possible recycling. The volume of wood material used in different processes will be inventoried and sustainability indicator values will be attached in each process. The indicators should be selected taking into account both their *relevance* in terms of sustainability assessment and *feasibility*, based on data availability and quality.

4. Assessing sustainability impacts of alternative FWCs

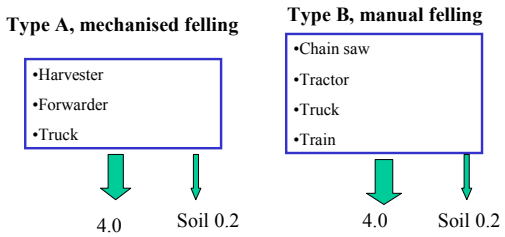
The simple FWC depicted by an arrow line in Figure 2 represents only one of many possible pathways to grow wood material and convert it to a final product. If individual processes in the FWC are modified, the associated sustainability impacts will be directly affected. For example, if a harvester is used for cutting trees instead of manual felling, this process may become more economic, but the number of jobs in tree harvesting will most likely be reduced. Similarly, shifting the transport of wood from truck to railway – as set as a target in the EU strategies towards sustainability – would probably result in improved environmental indicators. By comparing alternative FWCs it is possible to improve the sustainability of FWCs and the trade-offs between different sustainability indicators can be identified.

4.1. Numerical example

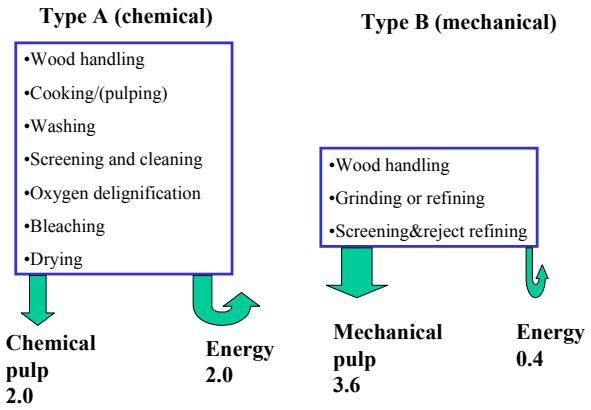
In the following, only one indicator, *carbon contents and releases*, from the processes is followed up throughout the chain. The example compares process options at various stages throughout the FWC, similar to a study by Liski et al. (2001). In each step, indicator values associated with two typical alternative processes have been derived. In this study, the carbon flow is related to the one produced by one hectare of forest land.



1. Different forest management strategies using shorter (A) or longer (B) rotation lengths will result in different annual carbon removals from the forest and in different carbon stocks in woody biomass and soil respectively.



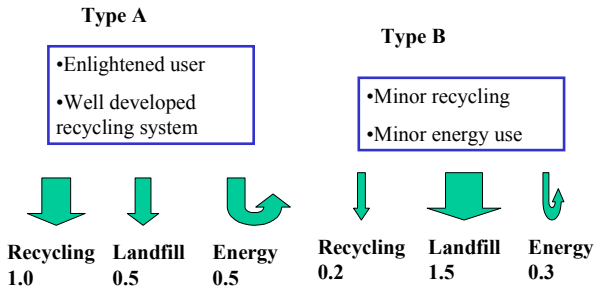
2. Let us now follow only the short-rotation chain producing carbon input from forest to industry 4.2 Mg per hectare annually. Again, there are two optional sets of processes for wood harvesting and transport, mechanised and manual felling. Regarding carbon, both are assessed equal. Regarding other sustainability indicators which may be selected (fossil fuel emissions, employment, impact to biodiversity, or recreation of forests, harvesting costs, etc.), there will most likely be differences which have to be taken into account.



3. In the next step wood is converted into pulp. The two main types of pulping, mechanical and chemical, differ substantially in output of the pulp and energy consumption. Again, the other indicators not discussed here, may differ as well.

4. In the paper mill, production processes of different types of paper do not differ regarding the carbon contents.

5. The same concerns the paper transport chains from mill to market. Only the other indicators except for carbon may differ from truck or truck/ship/train chains.



6. Finally, in the consumption phase, two types of societies may be considered which differ related to recycling rate and wastepaper collection for energy use.

The example accounts only the carbon contents of two optional forest-wood chain. By accumulation – for instance – labour days used in all processes throughout both chains, it would be possible to analyses the trade offs between environmental (carbon) and social (employment) indicators of two chains.

5. Discussion

We have used one example of a simple FWC with a limited number of alternative processes to illustrate how sustainability indicators – in this case carbon storage – can be assessed throughout the FWC. It is relevant to start with one hectare of forest, if the aim of the assessment is to consider carbon sequestration and rotation lengths as done in the study by Liski et al. (2001). The sustainability impacts of FWCs can also be assessed with a focus on a selected up-stream process of the chain. For example, if the goal is to assess the sustainability impacts of a paper mill, there are manifold options both upstream and downstream, as raw material may originate from forest management systems linked with a high number of different processes (including harvesting and transport) and a range of products may thus reach the consumers through alternative value chains.

On the way towards a sustainable society, research can help to assess the environmental, social and economic sustainability of the present production chains and to explore options for alternative chains

with improved sustainability impacts. The approach suggested here – mapping the processes within Forest-Wood Chain, following the volume of wood material flows through the processes and assessing sustainability indicator for each process involved – offers a concrete way to study the matter.

There are several questions that need to be considered in the sustainability assessment of Forest-Wood Chains:

- Which indicators to analyse? Depending on the focus – may it be SA of a forest industry company, a forest region, or a special wood-based product, the data availability and quality will vary and this will influence the selection of indicators and the elaboration of the SA approach as well.
- Which processes to select? How in detail do the processes have to be described depends also on the data availability and the potential use of the results. If the policy-maker wishes to know whether it is more sustainable to support natural regeneration of beech than planting of spruce, the land area available for both must be known and sustainability indicators derived for typical spruce and beech chains downstreams. If the focus is to optimise the sustainability of a forest industry branch, it will be necessary to distinguish between many separate processes within the industry.
- Which chains to describe? As the number of optional chains in theory can be high, the most relevant ones with limited number of process combinations should be selected for studying.

These issues have been considered by the 'EFORWOOD' consortium, which has submitted a proposal to the EU 6th Framework Programme, based on the principles described in this paper.

The method suggested may serve as a model for society on how to integrate environmental protection, economic growth and satisfying human needs. Using the proposed method, decision-makers will have the option to evaluate ex ante the effect of many different actions or events on the sustainability indicators of the FWC as a part of the European society, be they on social, economic or environmental dimensions.

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References

General declaration and resolutions adopted. 1998. Ministry of Agriculture, Rural Development and Fisheries of Portugal. 64 p.

Finnish Statistical Yearbook of Forestry. 2003. Finnish Forest Research Institute. 388 p.

Forest.fi- website. www.forest.fi

Hecker, M., Ressmann, J. and Becker, G. 1998. Wertschöpfungpotentiale und ihre Realisierung entlang der Holzerntekette. Forst und Holz 21:651–655.

Hytönen, M. (ed.). 1998. Social sustainability of forestry in the Baltic Sea Region. Proceedings of workshops organised by the Nordic Research Programme on Social Sustainability of Forestry (NORSUFOR), 30–31 January 1997, Helsinki, Finland and 10–12 September 1997, Kärdla, Estonia. METLA, Helsinki. 354 p.

Improved Pan-European Indicators for Sustainable Forest Management. 2003. MCPFE Liaison Unit Vienna. 6 p.

Kangas, K. and Baudin, A. 2003. Projections management models. In: Päivinen, R., Roihuvuo, L. and Siitonen, M. (eds.). Large Scale Forestry Scenario Models: Experiences and Requirements. EFI Proceedings No 5. European Forest Institute, Joensuu, Finland. Pp. 133–141.

Liski, J., Pussinen, A., Pingoud, K., Mäkipää R. and Karjalainen T. 2001. Which rotation length is favourable to carbon sequestration? Canadian Journal of Forest Research Vol. 31(11):2004–2013.

Vasara, P., Bergroth, K., Hänninen, K. and Jokinen, J. 2005. Energy transition and other technologies. Report from a project financed by the Dutch Ministry of Economic Affairs. Dutch Ministry of Economic Affairs and KVNP. In press.

Wilhelmsson, L. 2001. Characterisation of wood properties for improved utilisation of Norway spruce and Scots pine. Acta Universitatis Agriculturae Sueciae. Silvestria 216. Swedish University of Agricultural Sciences, Uppsala. Doctoral thesis. 112 p.

World Commission on Environment and Development. 1987. Our Common Future (The Brundtland Report). Report of the World Commission on Environment and Development (WCED). 318 p.

Zhu, S., Tomberlin, D. and Buongiorno, J. 1998. Global forest products consumption, production, trade and prices: global forest products model projections to 2010. Global Forest Products Outlook Study Working Paper No GFPOS/WP/01. Forestry Policy and Planning Division, Rome. 343 p.