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EDITORIAL

Challenges in implementing sustainability impact assessment of forest wood chains

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The concept of sustainability and impact assessment

Sustainability impact assessment (SIA) is gaining increased attention both in policy development and in strategic decision-making in the forest-based business sector and in society as a whole (Kirkpatrick and Lee 2002; Kirkpatrick and George 2005; Tscherning et al. 2008). The sustainability concept was originally developed in European forestry at a time of excessive forest exploitation that threatened the economy, because wood supply was crucial to provide energy to operate, e.g., glass manufacturers, iron smelters or salt mines, and to satisfy domestic demands of households in growing cities. To facilitate the sustainable provision of wood, improved forest management planning was introduced (Carlowitz 1713). The sustainability concept has been expanded over the centuries and is now widely applied to economic, social and environmental development in the context of all nature–society interactions. In forestry, sustainable forest management (SFM) has been adopted by international processes (Montreal process, Forest Europe), and consequently, criteria and indicators have been established to monitor SFM at the pan-European level. Development of environmental indicators for downstream processes was more directed towards the methodology Life Cycle Assessment (LCA) (e.g., Guinée et al. 1993a, b).

One practical application of SFM was driven by the introduction of forest certification, which established standards and provides guidelines for forest management. But despite improved information about progress towards SFM in various State of Forest reports (e.g. Howell et al. 2008), it is scientifically still difficult to judge whether a selected management system is sustainable. Defining thresholds for sustainability might work reasonably well where the concept of critical loads can be applied (cf. Groffman et al. 2006). However, thresholds for social indicators such as the acceptable frequency of accidents or for the number of jobs in rural areas are difficult to determine, as they would be largely based on normative value judgements. Sometimes it can be easier to state what is not sustainable: violations of critical functional requirements of systems can be taken as a clear indication of unsustainability, while non-violation may not be a guarantee for their sustainability (Bossel 1999).

Sustainability impact assessment offers a third approach which avoids evaluating a given situation as sustainable or not sustainable. A prominent example of this has been the ex-ante impact assessment of policies affecting land use conducted within the SENSOR project. The SIA framework in SENSOR was built around three questions (Helming et al. 2011): (1) What kind of land-use changes are to be expected as a consequence of policy intervention? (2) Where will the expected changes take place and what environmental, social and economic effects would they

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induce? (3) Will the expected effects matter in terms of regional sustainable development?

Based on the idea of developing a SIA tool for analysing complete values chains of the forest-based sector (FBS), the project EFORWOOD—Tools for Sustainability Impact Assessment of Forestry-wood Chains—was developed. EFORWOOD was designed to develop a comprehensive and objective methodology for the sector to analyse its impact/contribution to a sustainable development of society (Päivinen et al. 2011; Skogforsk 2010). Here, the questions were how changes in policies, resource management, technology or consumption would affect the sustainability of forest value chains. An important step in SIA is the specification of scenarios, because the impact assessment compares sustainability indicator values between alternative scenarios. This approach shifts the focus from an absolute sustainability assessment (that would require specification of thresholds) to a relative sustainability assessment, where the question is which of the scenario alternatives is more sustainable. Applying SIA for a complete value chain proofed to be challenging. In the following sections, these challenges are discussed.

This special issue is based on presentations given at the final conference of the EC FP6 funded Integrated Project Sustainability Impact Assessment of the Forestry-wood Chain (EFORWOOD) held on 23–24 September 2009 in Uppsala, Sweden. At the conference, not only contributions representing forest-based sector-oriented SIA research as such were presented but also SIA-related research for other bio-based production sectors was included as well.

Challenges in implementing SIA for the forest-based sector

How to mirror sustainability impact using indicators

Within EFORWOOD, a comprehensive set of indicators was developed for the complete forestry-wood chain, covering the environmental, economical and social aspects of sustainability (see Pülzl et al. 2011). A general requirement for the indicator set was that it should be consistent with other sustainability indicator frameworks developed in Europe and globally. The indicator set needs to address all major sustainability impact dimensions as well as indicator demands of multiple user groups, including policy makers. The final choice of indicators is based on certain basic requirements such as, feasibility, data availability and applicability to selected processes, as well as its potential to contribute to the assessment of sustainability impact. The same considerations have to be taken when applying the indicators in the sustainability impact assessment.

The challenge of collecting data

Without harmonized data, or data of good quality, modelling is in vain. This is a basic prerequisite for any modelling project. For EFORWOOD, where data of very different origin and nature were collected, this was especially the case. Data did not only originate from different EU countries and business areas but were also collected by different groups and for various processes in the forest value chain. Harmonizing the scientists' different perceptions and getting to learn and understand one another's language and processes was a challenge. The writing of strict Data Collection Protocols (DCP) was necessary to achieve a reliable database (Berg 2008). Development of DCPs was carried out as an iterative process. After extensive tests, using case studies, they were re-assessed and finalized. Data are generally quite well accessible and harmonized for the forest part of the chain, but further down the chain and into processing, manufacturing, consumption and end-of-life, data are more scarce, vary in methods by which they have been assessed and are available only in a fragmented way. Also Europe knows geographical areas where data are more available compared to others. To feed the model with as reliable data as possible, different data sources were used such as European and national statistics, model generated data and, in some cases, also expert guesses. Conversions and assumptions had to be made for less data-rich regions. In certain cases, new data generating models were developed within the project (see e.g. Chesneau 2011). Furthermore, products tend to get mixed during processing, thus further complicating the data collection and harmonization. Companies do not necessarily collect or communicate data which are related to their production. The downstream products are in the statistical data defined as functional units (windows, doors, furniture, etc) or tons of products. To be able to make a sustainability impact assessment for forestry-wood chains, data on the fraction of wood in these products are needed. To get around at least some of these difficulties, the concept of "model mills" was used to derive needed data.

Very often, real validation data did not exist, and results could only be checked against aggregated statistics. Simpler, single-chain simulations provided output that directly or indirectly addressed the indicators and might seem more accurate or less complicated. However, for larger-scale policy impact assessment, single-chain assessments cannot be directly translated or extrapolated. In data collection, the important effects of system boundaries need certainly be taken into account.

Building and testing decision support tools for sustainability impact assessment

Developing decision support tools should always start with stakeholder interaction to know what practices are currently used and how the new tools should be designed to be accepted by the target users (Gamborg 2010). Assessing sustainability of complete forest value chains is by no means a trivial exercise, because of the sheer complexity of the systems and the multiple dimensions of sustainability.

When the planning of developing a decision support tool started in the EFORWOOD project, different alternative approaches were considered. Integrated dynamic/mechanistic modelling was considered as one option. But most existing models emphasize only a part of the forest value chain and are usually less detailed in other parts. Linking several complex submodels into one big tool can be challenging, as it gets difficult to understand the overall behaviour of such complex tools. Building a new mechanistic tool for complete forest value chains, on the other hand, would take more development time, and problems in software development could easily threaten the overall project success. EFORWOOD therefore opted for a third, data-driven approach of a balanced representation of FWC segments and processes based on statistics, indirect model linkages and expert judgments (Päivinen et al. 2011).

However, the complexity of the European forest value chains was still at hand. Experience showed that implementing a new SIA method should go step by step, starting small to understand the key dynamics, and only later increase complexity of the systems under investigation. After several years of development, the scientific community has learned a lot of lessons in SIA. Perhaps the ambition of developing a decision support tool for the whole European forest sector was too high. The methods that were developed proved to work, but they need more testing and perfecting in smaller case studies, before the tools can be considered robust and flexible enough to be used also in more complex cases (Lindner et al. 2011). The consequences of defining and selecting the system boundaries along the value chain need also to be further evaluated. Among other things, system boundaries are dependent on geographical considerations (trade) as well as interference with other value chains including forest-based materials, for example related to furniture, construction and packaging.

The knowledge base has been greatly expanded, covering multiple sustainability indicators for complete value chains. These reference data will certainly be of value also for further assessments. Through the process of developing an SIA decision support tool, the importance of the stakeholder engagement process was reinforced. Transparent implementation of subjective evaluation preferences is a key for the acceptance of the decision support tool. An example of a limited implementation of ToSIA for a specific part of the chain, namely the logging operations, is given by Berg et al. (2011).

The decision support tool produced by EFORWOOD is a major step forward in making the concept of sustainability impact assessment of complete industrial sectors visible in all its complexity. However, the most prominent result of the project is probably the interchange and discussions with stakeholders of the forest-based sector and their views on the implementation of SIA in practice. Furthermore, the development of model applications for specified FWC activities such as the “transport tool” (Chesneau 2011) has the potential to contribute to overall decision on SIA.

Evaluation and interpretations of changes

The decision support tool developed in EFORWOOD is based on the assessment of a large array of indicators aiming to mirror the sustainability of the system of FWCs. However, the indicator values assessed needs to be evaluated in order for the user to be able to interpret the results. In EFORWOOD, three complementing evaluation methods were proposed and developed, multicriteria analysis, cost–benefit analysis and a policy analysis.

Since the concept of sustainable development is not a pure scientific concept but involves societal values and preferences, the evaluation relies on selected indicators as well as on how indicators are weighted against each other. This calls for an active involvement of stakeholders (Gasparatos et al. 2008). Multicriteria analysis (MCA; e.g., Gamper and Turcanu 2007) is one approach proposed for evaluation in SIA and has gained increasing legitimacy in governmental decision-making and as a decision support tool in public processes (Wolfslehner et al. 2011). MCA is especially useful in multi-indicator evaluation to perform a rational and transparent decision-making process for SIA. The MCA module developed within EFORWOOD allows for the calculation of relative sustainability impact rating and is based on a PROMETHEE II algorithm. Further, it is possible to perform an uncertainty analysis to test the stability of ranking results in the absence of real preference information.

While MCA allows for comparisons of indicators of different measuring units, the evaluation based on cost–benefit analysis (CBA) is implemented in order to, as far as possible, convert indicator values into monetary values. This approach allowed monetary value estimates to several of the externalities related to the EFORWOOD indicator set (Prokofieva et al. 2010). Examples of indicators included in the CBA of the EFORWOOD project is recreation, non-greenhouse gas emissions, GHG emissions, carbon stock and water pollution. Other indicators, describing externalities, are possible to include in future developments of the tool.

A database, covering all EU policies of key relevance to FWC sustainability, was employed for the purpose of connecting the EFORWOOD sustainability indicators to its institutional and political background. This connection provides direct and detailed insights into the governance structures prevailing in the European forest-based sector and thereby into the institutional dimension of FWC sustainability (Vogelpohl and Aggestam 2011). The policy evaluation tool enables the comparison of FWC indicators with threshold values as identified in EU policies. The institutional sphere is of critical importance in the development and implementation of SIA. Society's perception of sustainable development varies over time. This is expected since the concept does depend not only on science but to a great extent also on societal perception and values.

Conclusions and outlook

This special issue focuses on sustainability impact assessment of man's activities to make use of natural resources to satisfy the needs of human society. Focus is set on forest-based resources. A major part of what is presented is based on the results from the EU FP6 integrated research project EFORWOOD, which developed a novel, quantitative decision support tool (ToSIA) for sustainability impact assessment (SIA) of the European Forest-Wood Chain (FWC) (Lindner et al. 2010, 2011). The objectives were achieved through integrated activities in a multidisciplinary research environment. Economic, environmental and social sustainability indicators were selected and defined, and a tool for decision support of SIA was developed. Some examples of other aspects of sustainable development and SIA were presented by invited scientists from outside the EFORWOOD project.

The role of forests and forest-based products in reducing carbon emission thereby mitigating climate change was discussed by Eriksson (2011) and Dias et al. (2011). Eriksson studied three different scenarios for the use of wood as building material. The conclusion was that only the extreme scenario characterized by a consumption of 1 m^3 a^{-1} of wood per capita had a significant impact on carbon emissions, volumes and trade flow. He suggested that realistic increases in wood construction will have a minor impact on forest management and carbon stocks. The study by Dias et al. quantified the contribution of harvested wood products to the carbon removals/emissions by agriculture, forestry and the land-use sector in a case study for Portugal.

A specific angle of sustainable forest management (SFM) was studied by Carbone (2011). The use of the legal framework of forest policies for forest indemnity and its implications for the efficient support of SFM was studied for the Lazio region of Italy. In an analysis of 30 years of practice, the study highlights the intrinsic potential for improving the environment and the serious effects when it is misused to intervene in precarious ecosystems. An important feature required for SFM at the European scale is improved insight into the forest resource and its characteristics. One step forward in this is the distribution of tree species for Europe as mapped by Brus et al. (2011). They provided for the first time a medium-resolution tree species map, harmonized for Europe, based on a combination of NFI plot data, ICP data and regressions on abiotic characteristics.

Vesterager et al. (2011) proposed an Agri-Environmental Footprint Index (AFI) customized to local stakeholder preferences, using expert knowledge for assessment of impacts and sensitivity, and indicators of the environmental state at farm level.

Since the Bruntland report (WCED 1987) the concept of sustainable development has gained in interest and acceptance in the political as well as in the scientific communities, later also in business and industry. The latter, not the least driven by consumers who are prepared to pay more for goods that can show that they are produced in a sustainable way. This development calls for a scientific and systematic approach to SIA in order for society to be able to agree on common, accepted standards. The science behind sustainability assessment is still young, and political and industrial decision makers are still not prepared to fully accept emerging methods. For this, models and decision support tools have to be further tested, evaluated and standardized. Although in an early development phase, ToSIA and related methods and approaches discussed in this special issue have the potential to provide policy makers, forest owners, the related industries and other stakeholders with decision support to identify the forest-based sector's impact/contribution towards a more sustainable Europe.

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