Focus on wood - opportunities and limitations of life cycle analysis (LCA)

EXECUTIVE SUMMARY

The environmental use of wood resources was the topic of the 60th LCA Discussion Forum, which took place with around 70 participants from Switzerland and abroad at ETH Zurich on 4 December 2015. The presentations highlighted the climate-protection potential of the wood sector, they detailed the impressive potential of life-cycle analysis (LCA) while also casting light on methodological issues that remain unsolved to date.

The topic was chosen upon completion of several studies into the ecological use of wood in Switzerland, undertaken in the context of the National Research Programme "Resource Wood" (NRP 66) of the Swiss National Science Foundation (SNSF). In tandem with other contributions, the results of these studies were presented to a wider public for the first time.

Divided into four thematic blocks, the forum put the spotlight on four aspects of LCA (Life Cycle Analysis). Block 1 focused on databases for LCA, while block 2 was dedicated to methodological developments in impact assessment. Block 3 dealt with issues related to the calculation of the ecological footprint of various innovative wood-based products, by combining theory and practice; block 4 looked at different approaches to forest management and wood use, as well as their ecological impacts, from a systemic perspective.

Methodological challenges

Each LCA is based on large data sets that quantify the environmental impact of various logging methods or wood-based products. The ecoinvent database, co-financed by the FOEN, has just been updated and will allow for more accurate LCA calculations. There is, however, further room for improvement as not all material flows have been captured yet. Methodological questions include how to draw system boundaries and how to choose the observation period. It is difficult to capture the interaction of natural processes and human interventions; depending on the chosen approach the results can be diametrically opposed: replacing a product with a wood-based product may be deemed climate-friendly according to one approach, while another one leads to the opposite conclusion. The LCA approach is more accurate if the natural reduction of greenhouse gases, i.e. effects of the biosphere, are also considered. The inclusion of this aspect does not make the calculations any easier. But they promise a more precise evaluation of measures to reduce the emission of greenhouse gases and, as a result, reduce the risk of investing in climate-protection measures that have little or no impact. If LCA is used in combination with methods such as species-area models and vulnerability indicators, it is possible to identify how various land management approaches influence biodiversity – at the global, regional and local level. The results of these observations underline the importance of accurately assessing the global environmental impact of wood-based products, which are often consumed far away from the place of production. (Presentations by: Frank Werner, Environment & Development; Frida Røyne, SP Sweden; Francesco Cherubini, NTNU Norway; Abhishek Chaudhary, ETH Zurich.)

Ecological footprint of timber-frame buildings and green energy

If wood is used to replace materials that consume a lot of energy, there is a positive effect on the climate – this is the generally accepted opinion at home and abroad. Consequently there is great, quantifiable potential when existing buildings are renovated in Switzerland. According to Norwegian figures, the lighter weight of wood accounts for much of the positive effect: using wood on existing foundations, it is for example possible to replace old buildings with higher structures

(accommodating more storeys). It is therefore important that we consider not only properties such as noise and fire protection when comparing buildings of comparable functionality but that we include weight in our calculations. But the climate-friendly characteristics of wood are not limited to its use as a building material as wood is also a climate-friendly energy source. The canton of Vaud covers 10 to 15% of its energy requirements with wood. Not all heating technologies are equally efficient though: wood to gas conversion receives the best marks if the waste heat is also used. A study from Bavaria confirms the positive climate impact of wood as a source of energy. However, if the analysis considers not only the emitted greenhouse gases but also particulate matter, wood for energy use is not entirely unproblematic. But if Bavaria were to stop using wood for energy altogether, this would result in the emission of an additional 6.4 million tonnes of greenhouse gases. Such figures show that LCA can be used to highlight the impact of political targets. (Presentations by: Niko Heeren, ETH Zurich; Lars Tellnes, Norwegian Wood Technology; Denis Bochatay, Quantis; Christian Wolf, TU Munich.)

From lightweight timber construction to bio-refineries - innovative wood-based products in the spotlight

Research is currently developing new wood-based products for the building sector, such as innovative panels and boards displaying a host of desirable properties such as low humidity content and good thermal insulation. An example for such a new product is "holzpur", which does not require chemical treatment or glue of any sort. The life-cycle assessment shows that this product is therefore more environmentally friendly than glulam. The situation is slightly different for the ultra-light panels that were also showcased: they owe their lightness to a biogenic foam core but the ecotoxicity of the currently used foam limits their eco-friendliness. When assessing wood-based products it is key to consider the entire, cascaded life cycle. The positive properties of wood in the use phase are often due to (chemical) treatments in the production phase. This also creates a negative environmental impact in the disposal stage. Labels could help people in the building sector to choose the most environmentally friendly products. Standards for this purpose are currently being developed. LCAs that differentiate between various time spans and different forestry structures could make it possible to quantify the climatic impact of forests and wood-based products more accurately. All in all, this approach, too, confirms that climate change is effectively slowed down by replacing fossil-based energy and products with wood. Bio-refineries open up yet more ways to use wood: in addition to serving as a basic product for the building and packaging sector, wood can be transformed to replace a whole range of oil-based products. However, the necessary chemical processes use a lot of energy and resources and the finished product is generally the result of various reaction chains. For businesses it would be helpful to know which reaction chain is the most economical and allows for the further use of residual materials. The newly developed "Wald-Box" makes it possible to compare potential production processes and to evaluate the efficiency and environmental impact of various bio refinery concepts at the planning stage. (Presentations by: Philippe Stolz, treeze Ltd.; Christelle Ganne-Chédeville, Bern University of Applied Sciences; Andreja Kutnar, University of Primorska; Merten Morales, ETH Zurich; Antti Kilpeläinen, University of Eastern Finland.)

Forests as a system and their impact on the climate

Optimised concepts of forestry management that take account of forests all over Switzerland could reinforce the climate-friendly impact of intensified wood use. By casting a systemic look at the entire production and use of wood in Switzerland, it is possible to link management issues to material-flow analyses and LCA. Different wood-based products affect the climate in different ways. The positive impact of the current use of waste wood is still marginal even though research has shown that cascaded wood use can alleviate climate change if wood replaces energy intensive materials and is used for energy production at the end of its life cycle. A look beyond Switzerland

to Europe sees the positive environmental impact of forests and the intensified use of wood confirmed. The LCA approach allows for differentiated results according to the forest type and management system and it can be adapted to different periods of analysis. On the basis of this, we gain a better understanding of forest dynamics. If we include economic indicators (such as wood price and unemployment figures), LCA-based simulations are effective tools to assess political measures at an early stage and to detect measures that counteract each other or have a negative impact in the long run. (Presentations by: Florian Suter, ETH Zurich; Giuseppe Cardellini, KU Leuven; Frank Werner, Environment & Development.)

Conclusion and outlook

The concluding panel debate underlined that a more detailed analysis of spatial and temporal system boundaries of LCA is likely to push the method forward. However, concerns were raised that increasingly complex calculations might be confusing and difficult to communicate. In view of spreading information among practitioners, it will be crucial to break down complex results into simplified messages. It was felt that researchers should be more involved in the dialogue with key stakeholders in order to influence economic and political decisions based on new insights gained through life-cycle assessment.

Author: Lucienne Rey (texterey.ch)