Timber and the circle of life

Life-cycle assessment could be used more for comparing the environmental impact of tropical timber against substitute materials

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AT THE request of the International Tropical Timber Council's Committee on Economic Information and Market Intelligence, I recently carried out a review of the application of life-cycle assessment (LCA) to tropical and other timbers. The aim was to "examine the role of LCA as a potential tool for assisting the competitiveness of tropical timber in the marketplace". So what is LCA, and what do we know about its possible value for determining the environmental impact of tropical timbers?

Long haul: harvesting is just one element to be considered when evaluating timber's environmental credentials. *Photo: CIB*

LCA can be applied to all types of products to analyse a range of environmental impacts—like greenhouse gas emissions, resource depletion, acidification, eutrophication and land-use effects—caused during their entire life-cycle. Often referred to as cradle-to-grave assessment, LCA accounts for the environmental impact caused during the extraction, manufacture, transport, use and disposal of a product.

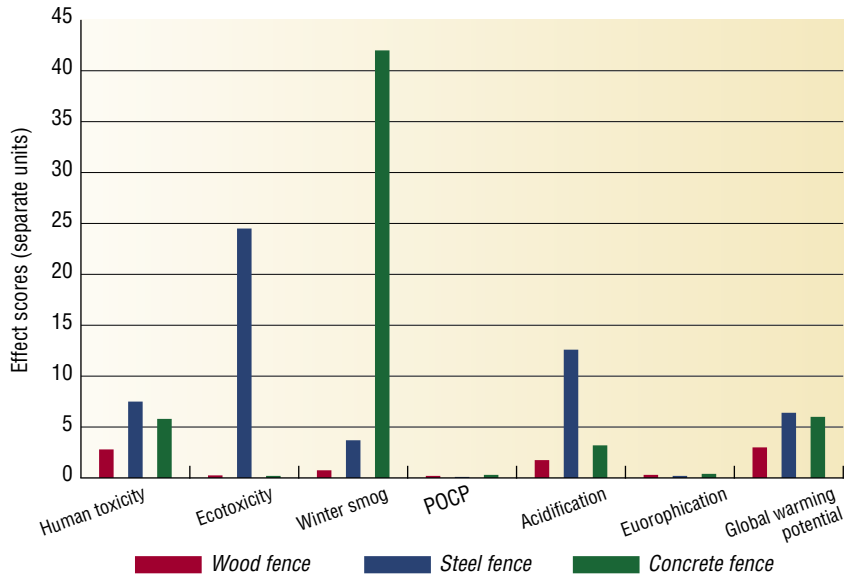
Because LCA includes all stages in the product's life-cycle and looks at a wide range of environmental impacts, it can be very useful when comparing materials of different origins—such as wood, polyvinyl chloride (PVC—a plastic) or aluminium—that can perform the same required function. Using LCA helps us to avoid over-emphasising single issues, such as the extraction or waste disposal phases of a product, when we are trying to understand the total environmental impact caused by a product. It forces us to base our judgements on the impacts of all stages in the product's manufacture, use and disposal.

The good news is that, in general, LCAs have shown timber to be an environmentally superior material to alternatives such as plastics and concrete. An example of such an LCA study is that of Hillier and Murphy (2000), which showed that a treated softwood timber fence caused a much lower environmental impact than alternatives made from steel or concrete over a predicted 50-year service life *(Figure 1)*.

In a comparison of window materials for domestic housing, Frühwald et al. (2003) showed that timber was again superior to other common materials, in this example for its relatively low potential to cause global warming (GWP)—see *Figure 2*. This study also showed that, regardless of the material used for framing, the use phase of the window contributes most to environmental impact, due mainly to heat losses (but also, for wood, to the need for paint). If the contributions of all except the use phase are considered, the contrast between the three materials specified for the frame are even more significant, with the wood-frame material contributing a *negative* GWP (ie *a reduction* in global warming potential) due to the sequestration of atmospheric CO_2 during the growth of the tree and its later locking up in the window frame. The aluminium and PVC window frames both caused a positive GWP (even discounting the use phase) due to the much higher amounts of energy required for their processing.

A hurdle for fences

Figure 1: Summary LCA results from Hillier and Murphy (2000) comparing copper-chrome-arsenic-treated softwood with steel and concrete for fencing *(POCP = photochemical ozone creation potential)*



Tropical timbers

Very few LCA studies have been conducted on tropical timbers to date. This review was able to find only one (VROM 2002) that was in full accordance with the ISO (International

Standards Organisation) 14040 series of standards for LCA. In this, the use of acetylated (a new wood-preservation technique) pine timber from the European Union (EU) was compared with two alternative, naturally durable timbers—larch from Siberia and azobe (*Lophira alata*) from West Africa. The product modelled was sheet piling in an urban waterway in the Netherlands. Though not the primary focus of the study (which was to evaluate the impact of acetylated pine), the results indicated that the LCA profile of azobe compared very favourably with the two softwood species for this product. However, it was also clear that the tropical wood caused higher greenhouse gas emissions in harvesting and transport.

This factor was investigated further in the review of some limited LCA database information. This also showed, unsurprisingly, that a substantially higher energy consumption is considered necessary to harvest and deliver tropical wood to the market in the EU compared to 'local' softwoods.

The goods on wood

Summary of environmental advantages and disadvantages of timber materials in comparison with alternative materials as revealed in LCAs

LIFE-CYCLE PHASE	Advantages for timber	Disadvantages for timber
Raw material origin	CO_2 removal from atmosphere, provision of ecosystem services, renewable with appropriate management	Extensive land-use
Harvesting/extraction	Relatively low energy and material needs	Ecosystem damage, greenhouse gas emission due to disturbance, transport distances
Processing	Low energy consumption, useful by- and co-products, potential for energy generation	Low recovery rates (tropical), transport distance
Use	High strength to weight, good thermal properties	Additives may be needed to enhance durability
End-of-life	Multiple re-use, recycling and energy recovery options, energy recovery can substitute fossil energy needs	Need to segregate contaminated wood, downgrading in recycling

Land-use

There is a further difficulty, and a serious risk of inaccuracy, in LCA studies on tropical timbers. This comes from attempts to include a land-use category in the LCA analysis. It is certainly desirable to assess how the extraction of natural resources like timber can affect land (eg through occupying an area, effects on biodiversity, effects on primary productivity, and changes of land-use from one condition to another), but the methods for doing this in LCA are subject to much controversy. In general, there is great difficulty in truly representing in a relatively simple and comparative way the complexity of the systems involved. The problem arises for tropical timbers when poor estimates of the effects of forest extraction on land-use are incorporated into LCAs. This can lead to heavy penalties appearing to be borne by tropical timbers when their environmental impact in the land-use category is compared with those of temperate timbers or other materials like plastics and metals. Given the uncertainties over LCA methodology and data quality in this area, comparative LCAs between tropical and temperate timbers where the overall conclusion is strongly influenced by the land-use category should be regarded with great scepticism at present.

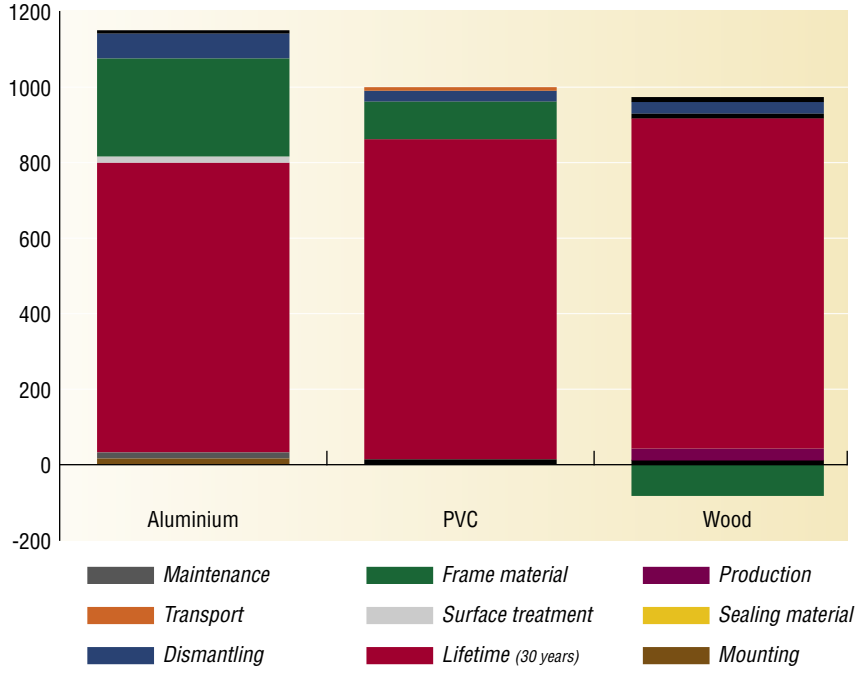
LCAs themselves do not *certify* that a particular area of forest is being managed on a sustainable basis. There are much better and more specific tools for this (see Eba'a Atyi & Simula 2002, Nikinmaa & Lounasvouri 2003) and ITTO, among others, has worked hard to make such tools more widely available. In order to advance the cause of tropical timbers in LCA, it is necessary to study how the integration of good data on the land-use effects from verified, sustainable tropical forest management affect the outcomes of full LCAs on tropical timber products, especially in comparison with some of the assumptions that have existed until now. The combination of LCA results with the results of certification activities will offer a more comprehensive assessment of the sustainable management of an area of tropical forest and of the environmental credentials of products made from that timber.

More LCA studies needed for tropical timber

The study involving azobe referred to above shows that LCA results for tropical timbers can match or be superior to those for temperate timbers. This gives some cause for optimism that better data for LCAs on tropical timbers will show that environmental benefits can be obtained from their sustainable use.

Window warmers

Figure 2: LCA comparison of the global warming potential of materials used for window frames, as indicated by emissions of CO_2 equivalents *(from Frühwald et al. (2003))*



End of the line? Under LCA, the fate of waste wood will help determine the environmental impact of timber relative to that of substitute materials. *Photo: CIB*

However, it would be naive to assume that tropical timber will always be favoured in LCA outcomes—instead, LCA should be used to identify cases where environmental support for tropical timbers is strong and to enable these strengths to be promoted. Attempts to hide behind inadequate data will not support the market for tropical timbers in the medium term because more and more LCAs are becoming available for the competitor materials and the market will respond accordingly to an absence of information. The existing LCA results indicate a strong case for timber as the material of choice on environmental grounds and this positive background needs to continue to be developed to include both tropical as well as temperate timbers.

Convincing the sceptics

Some people are sceptical of LCAs, which they perceive to be distorted or biased and can show varying or even conflicting results depending on how the study is conducted. A safeguard against inadequate studies is the full and transparent presentation of methodologies, data and results in accordance with the widely accepted ISO 14040 series of standards for LCA. This compliance with ISO should be the benchmark when LCA results are to play a crucial role in decisions. In some ways, LCAs are a bit like statistics or even economics—we may not quite like them but we don't have anything better!

LCA is an adaptable tool that provides a real opportunity to include the positive and negative aspects of forest products in a single framework to assess their overall environmental impact. The accumulating evidence from LCA studies on forest products is demonstrating the strong environmental benefits that occur when timber is used instead of alternative materials for numerous products. These benefits occur across all life-cycle stages of wood-based materials, from raw-material acquisition from a renewable and sustainable resource, through low-energy processing that also provides valuable and environmentally sound by- and co-products (bark, energy, particleboard furnish), to durable, high-specific-strength, easily modified products and an end-of-life phase that provides secondary raw material, recovered energy or a mostly benign return through natural composting and biodeterioration.

Timber-based products also have a range of negative impacts on the environment; the *table* summarises the main environmental benefits and disadvantages of timber materials (temperate and tropical) as revealed in LCAs in overall comparison to non-timber materials.

LCA is presently gaining in global significance. This is an exciting development and it is time for the tropical timber interests to take up the opportunity it presents.

Conclusions and recommendations

- In general, LCAs show timber-based products to have favourable environmental profiles in comparison with alternative materials
- The great majority of the LCAs conducted to date on timber products are based on temperate timbers—there are very few available LCAs on tropical timbers. Without action on the part of the tropical timber interests, this disparity is likely to increase
- Transparent and complete (to the ISO 14040 standard) LCAs are needed to provide underpinning information for communication of the environmental credentials of tropical timber products in comparison with alternative materials ('green' claims)—these demand best-practice in LCA and high-quality data
- If capacity is not built in tropical countries to develop *local* familiarity and competence in LCA techniques, there is a risk that tropical timbers will be represented inadequately in the market or, even worse, 'external' LCA studies may be done on the basis of inadequate data—especially for harvesting systems and land-use impacts
- LCA information has a key role to play in supporting the overall sustainability assessment of tropical timbers for both local and export uses. However, a co-ordinated effort is needed to:

  1) stimulate further LCA work and training of direct relevance to tropical forests and products; and

  2) establish a recognised centre where LCA information for tropical forests and products is collected and made available to LCA practitioners and the wider public, in a web-based form. ITTO could act as a centre for such an effort

References

Eba'a, R. & Simula, M. 2002. *Forest certification: pending challenges for tropical timber*. ITTO Technical Series No 19. ITTO, Yokahama, Japan.

Frühwald, A., Welling, J & Scharai-Rad, M. 2003. Comparison of wood products and major substitutes with respect to environmental and energy balances. Seminar for the Sound Use of Wood, ECE/FAO, Poiana Brasov, Romania, 24–27 March 2003. www.unece.org/trade/timber/docs/sem-1/papers/r32Fruehwald.doc

Hillier, W. & Murphy, R. 2000. Life-cycle assessment of forest products—a good story to tell. *Journal of the Institute of Wood Science* 15:4.

Nikinmaa, H. & Lounasvuori, J. 2003. Training local auditors. ITTO *Tropical Forest Update* 13:4. ITTO, Yokohama, Japan.

VROM 2002. LCA for acetylated wood. Final report 2: light duty piling in fresh water use. Conducted by the Imperial College London and SHR Timber Research for the Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM), the Netherlands. For more information on this study contact Dr Richard Murphy or Mr Ferry Bongers, SHR Hout Research, Nieuwe Kanaal 9b, NL-6709 PA, Wageningen, the Netherlands; f.bongers@shr.nl.