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Andreas Falk
KTH Royal Institute of Technology

Søren Løkke
Aalborg University

Environmental Science & Technology

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Wood As Construction Material: A "Common" Choice for Carbon Management?

Eva Ritter,* Michele De Rosa, Andreas Falk,† Per Christensen, and Søren Løkke

Department of Development and Planning, Aalborg University, Skibbrogade 5, 9000 Aalborg, Denmark

The interest in wood as building material is experiencing a renaissance, a development spurred by the concern about the global climate and the limit of natural resources. As opposed to other building materials, wood is a renewable resource. Wood structures of long-term durability can counteract increasing CO_2 concentrations in the atmosphere by several means: (i) The energy demand and thus the emission of CO_2 associated to manufacturing is generally less compared to the more widely used concrete or steel, (ii) the storage of C in wood structures delays its return to the atmosphere for the period of the lifetime of the structures, (iii) residues and byproducts can be recycled or burned and contribute to energy production, and (iv) the greatest part of the energy embodied in wood products can be reused for energy production when further recycling is inexpedient. The substitution of conventional building materials with wood may help reaching greenhouse gas (GHG) emission targets on a mid- to long-term basis.[1]

Nevertheless, the capacity of wood to contribute to the carbon management of the built environment goes beyond wood being part of long-lived structures. There are many processes and decisions along the production line that affect the overall carbon balance of buildings, as illustrated in Figure 1. Foresters make decisions about the choice of tree species and forest management mainly based on the conditions of the market, while ecological aspects are included to a far minor extent than expected from research or environmental planners. Foresters and saw-millers tend to be conservative and risk-averse in their approach because innovation is perceived as potentially loss-making. Architects and building owners tend to be more innovative and may want to use more timber species and products, but do not have sufficient knowledge to specify correctly and efficiently, and structural engineers and contractors lacking experience of using timber cannot provide this knowledge. Thereby, new products are not introduced, management and manufacturing methods not improved or alternative species not planted because of a missing confidence among several disciplines.

For the analysis of process/product related environmental impacts, life cycle assessment (LCA) has become a widely accepted methodology. However, without a sufficient exchange between the disciplines which have the knowledge of the various processes along a production line, important information for a comprehensive analysis may be left out. This also comprises individual and common driving forces along the production chain.

Comparative LCA studies of alternative building materials typically focus on the embodied energy and the CO_2 emissions related to the production of long-lived wood products, from window frames to structural elements and whole houses. Few studies include the analysis of C storage in forests, the influence of forest management or the demolition of wood structures.[2,3] Such an extended perspective can be advocated by the scope "from cradle to grave" in the EU document Horizon 2020 regarding direction of research programs.[4]

A further challenge of LCA is to take account for the effects of indirect Land Use Change (iLUC), which occur when land elsewhere is taken into cultivation because different crops are grown on the original area. The effect of iLUC and hence the outcome of a LCA depend highly on the dynamics of the forest systems involved and the methodological assumptions that are applied to model the forest C cycle.[5] We therefore argue that in order to correctly assess the C budget of wood products in the built environment, ecological processes and dynamics of forest ecosystems have to be considered more closely and be integrated among each other.

In addition to this, for a more comprehensive analysis of wood as an alternative *sustainable* construction material, the assessment of wood products should be able to take into account not only effects related to GHG emissions or sinks, but a wider set of impacts: repercussion on biodiversity, human needs, water footprint, etc. At present, the evaluation of the process/product related impact on societal issues and the consequences for biodiversity are largely missing. A holistic

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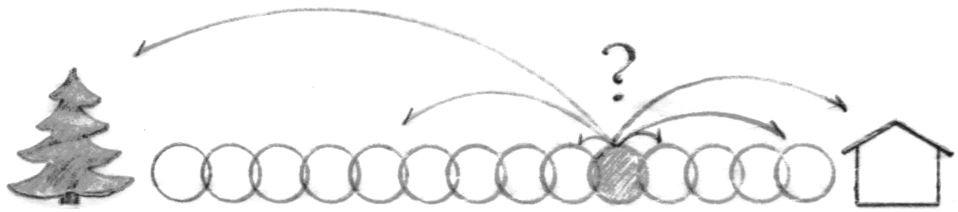

Figure 1. Every step and action along the wood production chain—from forest to finished building—has a relation to and an effect on both origin and end-product, regarding carbon management.

approach is necessary, capable to merge the knowledge of distinct scientific sectors. Forestry, material engineering, environmental sciences, energy technologies, and life cycle analysis are all developed disciplines; not always, though, are they integrated and cooperate to achieve a better assessment of the environmental and social impacts related to wood as a substitute for conventional materials in the built environment.

If the substitution of conventional materials with wood is to become a strategy in the plans of climate mitigation, a more precise evaluation is needed of the potential and the consequences of this action. In the end, the application of wood is limited, and so is the land available for wood production. To know these limits, and the consequences of management practises, is an important step toward solutions of a sustainable development in forestry, manufacturing and the built environment.

AUTHOR INFORMATION

Corresponding Author

*(E.R.) E-mail: er@plan.aau.dk.

Present Address

†(A.F.) Division of Building Materials, KTH Royal Institute of Technology, 10044 Stockholm, Sweden.

Notes

The authors declare no competing financial interest.

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