Exploring the Relevance of Uncertainty in the Life Cycle Assessment of Forest Products

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Akademisk avhandling

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Abstract
The role of forest biomass as a replacement for fossil fuels and products is becoming increasingly prominent as a means to mitigate climate change. To guide a sustainable transition towards a forest-based bio-economy, it is important that advantages and disadvantages of forest products are assessed, to ensure that the products deliver environmental impact reduction. Life Cycle Assessment (LCA) has become heavily relied upon for assessing the environmental impact of bio-based products. However, LCAs of similar product systems can lead to results that differ considerably, and the method is, thus, associated with uncertainties. It is, therefore, necessary to explore the relevance of uncertainties, to build knowledge about enablers and challenges in using LCA for assessing forest products.

Three important challenges in the context of uncertainty in LCA are the focus of this thesis: 1) system boundaries, 2) climate impact assessment practice, and 3) allocation. More specifically, the relevance of a) including and excluding life cycle phases, b) potentially important climate aspects, and c) applying different allocation methods, was assessed. Case studies involved a chemical industry cluster, a biorefinery, and single product value chains for a plastic box, a fuel, and a building.

In summary, the thesis demonstrates that:
- A major share of the environmental impact related to the production of an industry cluster can occur outside the cluster gates, so when strategies involving a transition to forest biomass feedstock are developed and evaluated, a life cycle perspective reveals the full environmental impact reduction potential.
- For bio-based products differing in functional properties from the fossil products they are meant to replace, material deterioration in the use phase can contribute substantially to overall environmental performance. This is acknowledged if all life cycle phases are regarded.
- As climate aspects commonly not assessed in forest product LCAs could influence results greatly, and even affect the outcome of comparisons between forest and non-forest products, the climate impact of forest products is uncertain. It is, therefore, important that this uncertainty is acknowledged and communicated, and that appropriate methods and guidelines are developed.
- The choice of allocation method in the LCA of biorefinery products can have a major influence on results, especially for physically non-dominant products and in consequential studies. In these cases, scenario analysis is especially valuable to show the possible range of results.

LCA provides useful guidance for forest product development and production as the life cycle approach reveals causes of environmental impact throughout the product value chain. Proper identification, estimation, and management of uncertainties strengthen the provision of reliable decision support.

Keywords
LCA, wood, forestry, uncertainty, biorefinery, industrial symbiosis, allocation, system boundaries, bio-economy