Factors contribute to the changes of LCA of wood products

Fanyou Wu, Eva Haviarova* and Jennifer Helfrich
Department of Forestry and Natural Resources
Purdue University

1 Introduction

Life Cycle Assessment (LCA) is a tool designed to quantify and evaluate a broad scope of environmental impacts from the selected life cycle of a given product. Life Cycle Assessment is one of the significant ways for the wood industry to promote the environmentally-friendly properties of wood with scientific evidence [1]. A classic LCA project is composed of three stages: defined scopes and goals, a Life Cycle Inventory (LCI), and a Lifecycle Impact Analysis (LCIA).

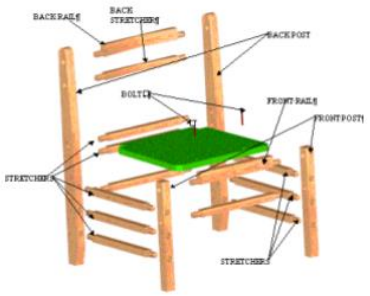

Figure 1: Exploded view of 14” chair components

In the last report, we focused on reporting our Life Cycle Inventory for a wooden chair produced in laboratory conditions. In this report, we would like to discuss several factors that contributed to the changes in LCA. Choices of functional units, geography factors, and transportation are discussed below.

2 Choices of Functional Units

The functional unit is defined as the unit of comparison that assures that the products being compared provide an equivalent level of function or service [2]. A carefully selected functional unit will improve the accuracy of the LCA study and the usefulness of the results. For wooden chair comparisons, a single chair is fair enough as the functional unit, though it depends on the changes of parameters e.g., joint system or material types, the lifespan and prices differ. Another optional functional unit for multi-type material comparison is to apply an equivalent lifespan. Figure 2 is one comparison LCA study on three different material chairs. We assess the environmental impacts of wood, plastic, and aluminum chairs. Here the functional unit is the 20 years of chair utilization while the lifespan of a chair is estimated based on the cyclic loads of chairs, which are 20 years for a wooden chair, four years for a plastic chair, and 6.4 years for an aluminum chair respectively. In this functional unit scenario, wood performs much better than other materials. If material quantity is used as the functional unit, then in some categories, wood becomes even worse than aluminum. These results also suggest that improving the strength and lifespan of products by adding no extra

materials could have a better environmental impact under some criteria.

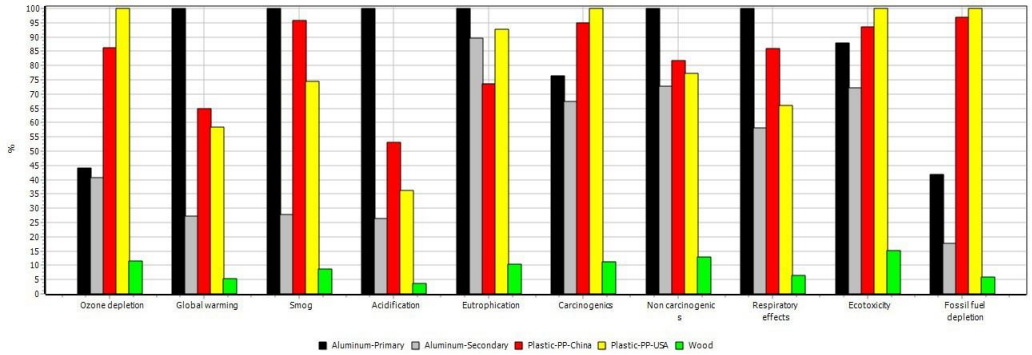

Figure 2: A comparison LCA on three different chairs based on TRAIC 2.1.

3 Geography factors

The geography factors are important for wooden furniture LCA due to their energy consumption during production. So, the location of production may dominate the overall environmental impacts. Here we present a comparative LCA on Indiana hardwood chair versus Oregon softwood chair, and the functional unit is one chair. The energy grades and wood species will affect the final outputs. Figure 3 is the result. We can see that in all categories, the Oregon softwood chair performs better than the Indiana hardwood chair. When lifespan is used as a functional unit, Oregon softwood might still perform better.

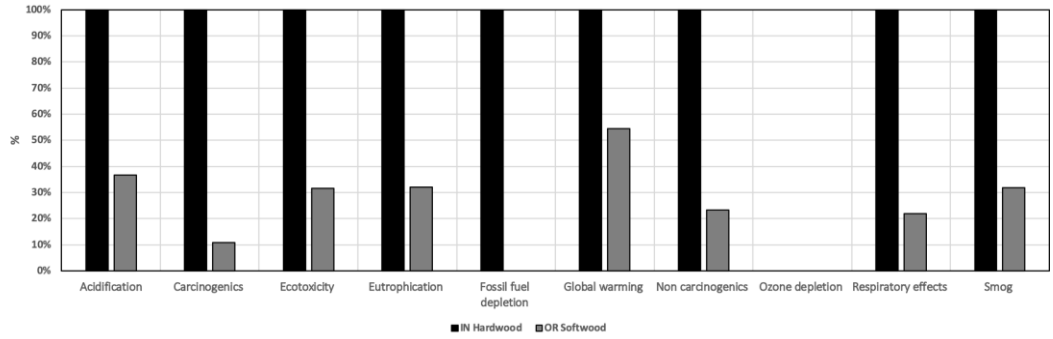

Figure 3: A comparison LCA on two different chairs based on TRAIC 2.1.

4 Transportation

The LCA studies above do not consider the transportation of raw material and product distributions. In the real-world scenario, the majority of wooden furniture sold in the US comes from China. Here we post a global warming potential (GWP) fitting based on our hardwood chair:

$$\mathrm{GWP} = 0.0807 \times T - 26.22 \quad (1)$$

where T represents good transportation with unit tkm. Here we assume that all transportation is based on trucks. The good transportation of a wooden chair from China to the US is about 170 tkm,, which releases almost half to the carbon storage in the wood. If the supply chains of wood products are more complicated, e.g., Canada produces softwood lumber; transports it to China, and then transports it back to Indiana as final furniture, then this might lead to positive GWP to the environment. So, for wooden furniture production, local production might be the best way in regard to the LCA perspectives.

References

[1] Maureen E Puettmann, Richard Bergman, Steve Hubbard, Leonard Johnson, Bruce Lippke, Elaine Oneil, and Francis G Wagner. Cradle-to-gate life-cycle inventory of us wood products production: Corrim phase i and phase ii products. *Wood and fiber science*, 42:15–28, 2010.

[2] Scientific Applications International Corporation (SAIC) and Mary Ann Curran. *Life-cycle assessment: principles and practice*. National Risk Management Research Laboratory, Office of Research and Development, US Environmental Protection Agency, 2006.