Introduction to Special Issue

CORRIM: Forest Products Life-Cycle Analysis Update Overview

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Since its inception in 1996, the nonprofit Consortium for Research on Renewable Industrial Materials (CORRIM; www.corrim.org) has developed comprehensive environmental performance information on wood building materials consistent with International Organization for Standardization (ISO) standards for life-cycle inventory (LCI) and life-cycle assessment (LCA) research. The majority of prior CORRIM work on structural wood products has been published in two special issues of *Wood and Fiber Science* (CORRIM 2005, CORRIM 2010) based on data collected and analyzed starting in 1999.

Many changes that were likely to affect the life-cycle results have occurred since the mill survey data were collected and compiled for the reports published in 2005 and 2010. These include changes in environmental regulations, both at the manufacturing facilities and in the forests; changes in operational efficiency due to forest sector restructuring after the 2008 economic downturn; and improvements in data quality across the supply chain. Market demand for consistent, transparent information on the environmental footprint of products has expanded greatly over the past decade. In particular, the emergence of environmental product declarations (EPDs) for North American wood products, which are based on specific guidelines as included in product category rules (PCRs), meant that data had to be reported in specific formats to be usable outside the academic community.

Taken together, these changes warranted this effort to revisit the 2005 and 2010 research, collect new primary mill survey data, update life-cycle inventory data to reflect current forest management and manufacturing operations, and revise life-cycle impact assessments (LCIA) for development of new EPDs. To that end, this special issue of the *Forest Products Journal* updates and expands on the prior CORRIM research of six structural wood products, with two regions analyzed for each product. In addition, we develop for the first time an LCA based on primary survey data on boilers used in forest product manufacturing facilities (Puettmann and Milota 2017). We also update regional forest resource life-cycle data for the Pacific Northwest (PNW) region and report on a strategy to develop longitudinal survey methodologies for continuous data collection.

Market (EPD) Influences on LCA Allocation Methods

Market forces are driving the development of transparent and credible information on the environmental performance of products that can then be reported in a standardized format known as a product eco-label. EPDs are a type of eco-label that summarize LCI and impact assessment data consistent with ISO standards (ISO 2006). Under ISO, EPDs are considered a Type III environmental declaration. Therefore, they must be based on an LCA and report on elements as required by the relevant PCR, in this case the North American (NA) Structural and Architectural Wood Products PCR (hereafter NA PCR) that was updated to meet ISO conformance requirements in 2015 (FPInnovations 2015). Following these steps ensures that products are comparable across a given product category. Bergman and Taylor (2011) provide specific details on this process for wood products, and the process has been adopted for the reports in this special issue.

The wood product LCAs in this special issue follow the allocation rule described in the NA PCR, which states that when the total revenue difference between the main product and coproducts is more than 10 percent, allocation shall be based on the revenue (economic) allocation. The 10 percent rule was applied on a per unit basis for each wood product. This change, while consistent with the NA PCR, means that

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Forest Prod. J. 67(5/6):308–311.
doi:10.13073/FPJ-D-17-00044

the LCA results reported in this special issue are not directly comparable to prior LCA results because the basis for partitioning the input and output flows for the product systems is completely different.

Where there are significant value differences between the main product and coproducts, economic allocation results show larger environmental impacts being attributed to the higher value product and consequently lower environmental impacts being associated with coproducts. Taylor et al. (2017) provide a good example of how this NA PCR change impacts the LCA using wood-based panels as the example product. However, economic allocation results vary considerably and can be expected to vary substantially over time because of the volatile nature of wood product pricing and large uncertainties in some of the pricing data (see Fig. 1, used with permission from Taylor et al. 2017).

Primary mill survey data were collected for the year 2012. Thus, the economic allocation is based on product values in 2012. Figure 1 shows that for the year 2012, framing lumber is near its 25-year average, whereas southern pine plywood is above average. Our collective observation over the course of this project is that economic allocation decreases transparency and increases the uncertainty of the results for several reasons. First, the markets do not move in lock step, which would make the relative values of products and coproducts stable. Often, the opposite is true. Historical records show that lumber and pulp prices are often countercyclical as well as volatile, so that when lumber is high, pulp is low, and vice versa (Howard and Jones 2016). As chips are often (but not always) sold as pulp, the ratio of prices changes substantially over time. In addition, pulp prices vary greatly among species and regions. Other market factors outside the LCI boundary influence these relative prices as well. They can include, but are not limited to, product demand; regional, national, and international markets for pulp and dimension lumber; established markets; natural gas prices; and requirements for fuel switching in support of renewable energy targets. Finally, the economic allocation method substantially increases the complexity of the LCA because virtually all primary products produce coproducts, some of which are sold and therefore have a market price, and some of which are used internally where proxy prices need to be developed in lieu of reported data. An example of a coproduct that might be used internally or sold is bark, which is sometimes burned in the boiler for energy and sometimes sold for use in gardening.

While economic allocations are reported in this special issue consistent with the requirements of the NA PCR, the challenges in interpreting economic data led us to take additional effort to increase the transparency of our results. To compare results with our prior work, we also presented LCA results using a traditional mass allocation approach, as was used in the 2005, 2010, and updated 2012 reports. These data are provided in each individual product LCA report available at www.corrim.org.

Forest Products Sector Structural Changes Influencing the Results

Since primary data on wood manufacturing were collected in the early 2000s, there have been enhanced environmental regulations surrounding emissions of hazardous air pollutants (HAPs) from wood products manufacturing, including boiler operation (Environmental Protection Agency [EPA] 2017). To meet regulatory requirements, manufacturing facilities have made substantial investments in emission control devices (ECDs), primarily for boilers used to generate steam and heat needed for their industrial processes. The addition of ECDs has two results. The HAP reduction targets resulted in a shift in technologies toward ECDs that can eliminate volatile organic compound emissions. In some cases, there was also an increase in the number and location of scrubbers aimed at reducing overall HAP emissions. Both these changes can increase the energy footprint of the manufacturing process because these systems are fueled by natural gas and electricity (Fig. 2). Bergman and Alanya-Rosenbaum (2017) take an in-depth look at the impact of ECDs on the overall environmental footprint for laminated veneer lumber and I-joists. They conclude that the increased energy use per unit of product relative to the older survey data can be considered an environmental trade-off to reduce HAP emissions. Data quality improvements could also be a factor in this increase in energy usage. For example, new standards within both

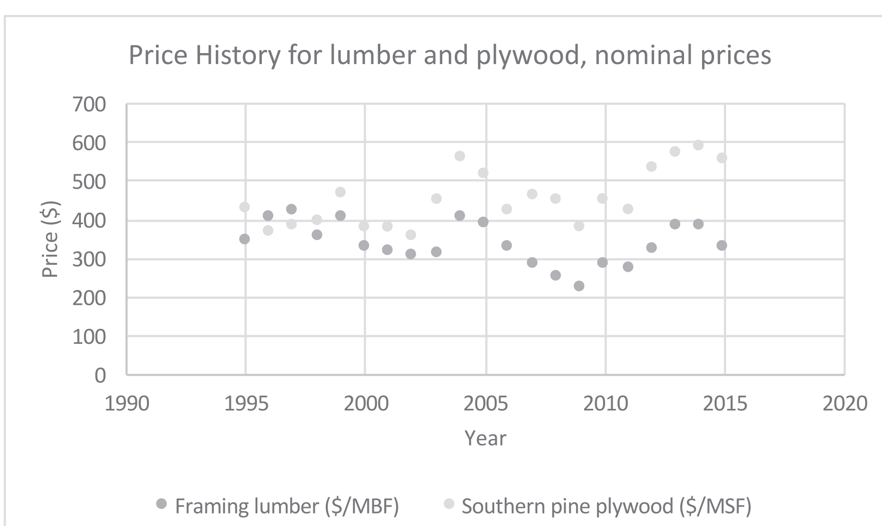

Figure 1.—Price history for lumber and plywood, nominal prices.

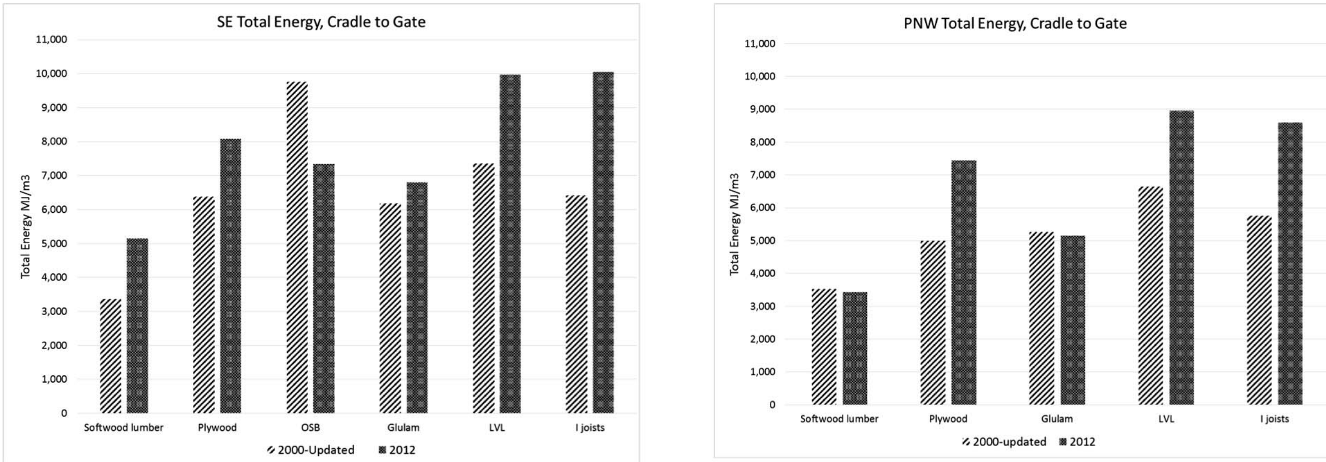

Figure 2.—Energy footprint comparison by product, region, and survey year. PNW = Pacific Northwest; OSB = oriented strandboard; LVL = laminated veneer lumber.

ISO and NA PCR require more detail on energy reporting. This increased level of detail was not part of the previous LCA results based on data gathered for earlier North American wood product manufacturing surveys.

External and internal pressures on the forest sector have resulted in substantial changes to the industry since data collection began in 1999. A major influence on primary survey quality and quantity was the 2007 to 2008 economic downturn, which resulted in substantial forest sector restructuring (Hodges et al. 2012, US Department of Labor Bureau of Labor Statistics [USDOL BLS] 2017). Depending on regional factors, restructuring usually meant fewer small and inefficient mills and a concentration of production at larger facilities. These economies of scale are captured in the data as increased efficiencies that may or may not have been able to offset efficiency losses related to emission controls as noted above. The increased interest in quantifying the environmental footprint of the sector and greater willingness on the part of large manufacturers to participate in the study meant that overall data quality is likely to be higher (Figs. 3 and 4). Taken together, these factors increase our confidence in the data quality and overall LCA results.

While the focus of this update was primarily on resurveying wood manufacturing facilities, a small portion of the project was directed toward updating and expanding our understanding of the environmental footprint related to forest management and harvesting. Oneil and Puettmann (2017) report on one of the four major wood producing regions of the United States: the Pacific Northwest (PNW). The PNW region covers the temperate forests of western Washington and western Oregon. In prior CORRIM forest resource studies, modeled forest inventory data were developed to represent average conditions across a range of yield and management assumptions. For this study, primary survey data were collected for industrial operations that represent 65 percent of the total annual harvest in the region. These data were augmented with other data sources to arrive at a more complete picture of the impact of forest management and harvesting in the PNW region, including an estimate of the carbon footprint of these operations.

The Future

In the introduction to the 2010 CORRIM special issue, Lippke and Wilson (2010) ended with a prediction that

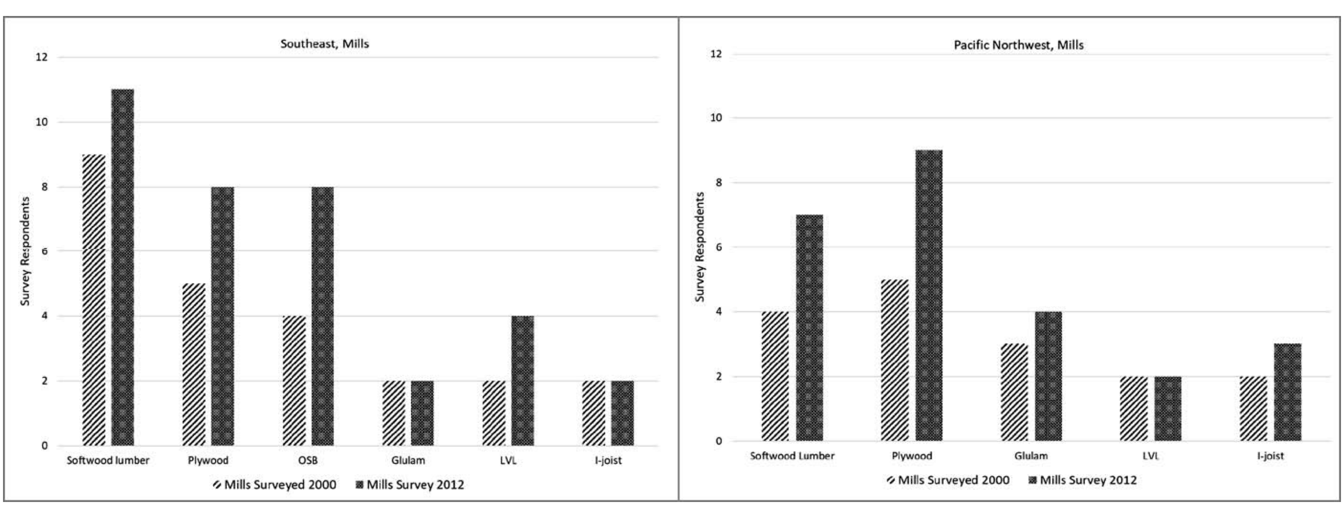

Figure 3.—Survey respondents based on regional production for the Pacific Northwest and Southeast US regions. OSB = oriented strandboard; LVL = laminated veneer lumber.

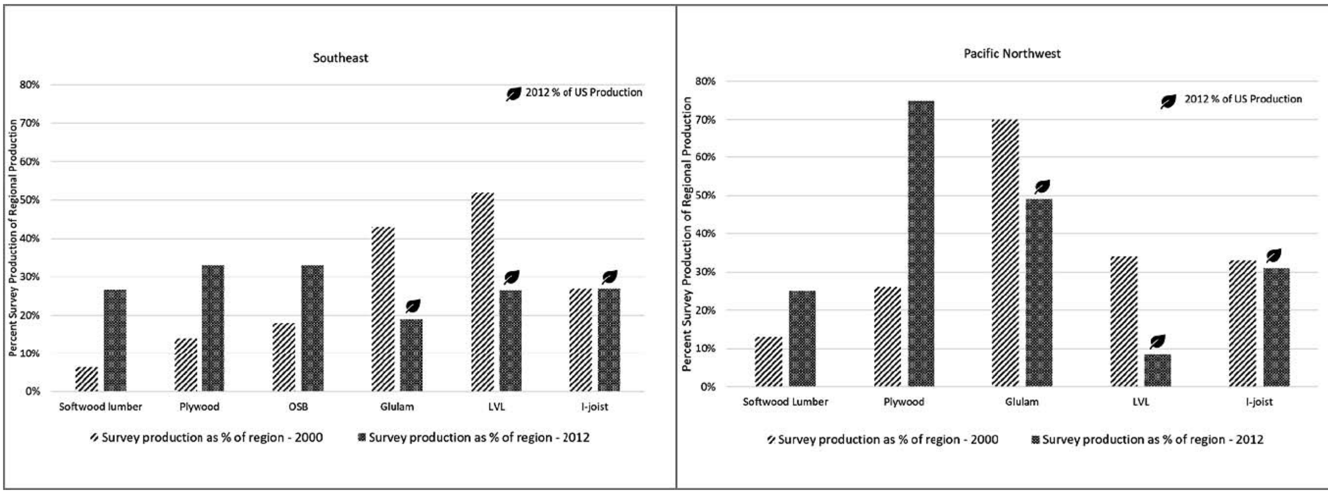

Figure 4.—Percentage of regional production surveyed for the Pacific Northwest and Southeast US regions.

''The emphasis on carbon as an important metric for judging sustainability will likely have a profound effect on our future and provides many opportunities for research as well as investment in improved performance.'' Even after only a few short years into the future, that prediction seems to be coming to pass. We see increased demand for information about the attributional life cycle of forest products. Market demands have led to the development of a PCR that requires the reporting of carbon sequestered in the wood net of production emissions. Architects and engineers are examining this body of work to find accurate wood LCA information to help improve the environmental footprint of their designs and construction (Simonen 2014, Mayo 2015). There have been many challenges of prior LCA work on wood products that demand studies go beyond attributional analysis to include the impacts of increasing demand on the forest resource itself. Given the interest in the attributional LCA work reported in this special issue, we expect it will face continued scrutiny and require continuous updates to remain relevant. Ultimately it will serve as a building block in larger studies that assess the economic, social, and environmental impacts of wood product use in current markets (e.g., softwood lumber) and emerging markets (e.g., mass timber construction).

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