Reused lumber: Building Michigan's future from trash

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Human demands on the planet for food, water, energy, land, and other resources are changing the earth's ecosystems and biodiversity, with human activities leading to climate change and increased pollution (Kolbert, 2014; Manu, 2019; Sanford, 2016). Further, society's focus on increasing the global gross domestic product (GDP) has resulted in an economy that does not allow all humans' basic needs to be met within the means of the earth (Raworth, 2017a & 2017b). The production of consumer goods to increase the GDP results in a large portion of the carbon emissions that contribute to human-caused climate change (Bergman et al., 2012; Kolbert, 2014; Khorasanizadeh et al., 2019; Manu, 2019; Ros et al, 2020; Sanford, 2016; Vita et al., 2020). Collectively, humans need to start considering the entire life cycle of the materials that we use, including what is done with these materials at the end of their current intended life. This is true for all consumer goods, whether it is packaging, electronics, or the buildings we live and work in, to develop practices that will allow us to live within the planet's confines (Berghorn et al., 2019; MacFarlane, 2009; Raworth, 2017). Looking at what we do with materials at the end of their initial life determines whether the material becomes trash bound for entombment in a landfill or a treasure to be reused or transformed into something else.

Salvaging, reclaiming, and reusing building materials -- particularly wood -- is important for several reasons. While forest ecosystems provide humans a source of building materials, they are also crucial to maintaining biodiversity and ecosystem services (United States Department of Agriculture, 2006; Wang et al., 2013). Forests provide shelter, food, and breeding areas for numerous animals, insects, bacteria, plants, and fungi (United States Department of Agriculture, 2006; Wang et al., 2013). They also provide important ecosystem services such as clean water and air (Leisen, 2017; United States Department of Agriculture Forest Service, n.d.). Forests contribute to human mental and physical well-being by providing places for recreation and meditation (Leisen, 2017; United States Department of Agriculture Forest Service, n.d.). Additionally, they contribute to the economy through tourism, the forest products industry, and hunting and fishing. However, mounting pressure on forest ecosystems

from climate change, increasing occurrences of wildfires, conflicting stakeholder needs, multi-user policies, and practices, and continued urbanization are pushing forests to extinction in many parts of the world (Abatzoglou & Williams, 2016; Kerr et al., 2018; Stevens-Rumann et al., 2018; United States Department of Agriculture, 2019; Wang et al., 2012).

Additional research is needed to improve scientists' understanding of how lumber is produced in Michigan, the way lumber production residuals are managed, how lumber is consumed in Michigan, and how forests are managed in order to better understand how to manage the production and use of lumber throughout its life cycle. Over 80% of the solid wood in the United States (U.S.) is used for lumber (Bratkovich et al., 2009). Currently, most lumber is produced from live trees referred to as green-cut or standing timber. A smaller portion comes from urban tree removal from private and public properties because of development or damage. The third source, reclaimed lumber, is the smallest and least utilized (Bratkovich et al., 2009). Deconstructing or dismantling buildings is a potential source for gleaning lumber that can be reused in Michigan. This can help reduce the amount of material going to a landfill; reduce lead releases, dust, and air pollution caused by demolition; create economic value for something that otherwise would result in a disposal cost; and reduce pressure on forest ecosystems from climate change and disturbance (Bratkovich et al., 2009; Ingham County Land Bank, 2015; USEPA 2019, May 23; Wood Products Council, 2020). The different lumber production scenarios and types of wood produced by each add to the complexity of evaluating lumber production's impacts on the climate and environment.

In Michigan, mostly softwood lumber comes from green cut timber, while urban timber tends to be mostly hardwoods, and reclaimed lumber is a mixture of both softwood and hardwood species (G. Berghorn, personal communications, October, 2020; D. Neumann, personal communications, October, 2020). Softwood lumber is used for framing buildings and has less economic value while hardwood lumber goes to more decorative uses such as flooring and trim, and has a higher economic value. Generally, if these materials are reclaimed from existing homes they will need to be refurbished by de-nailing, planning, removing paint, and sometimes they need to be

kiln-dried to remove moisture and potential pests (Michigan State University Center for Community and Economic Development & West Michigan Shoreline Regional Development Commission, 2017). Both the type of lumber, and its age and condition, among other factors, affect the economic feasibility and likelihood of reclamation. However, lumber used in framing pre-1940 homes is generally old-growth timber and is true dimensional lumber that has more value than lumber produced in more current times (Delta Institute, 2015).

Urban areas face challenges from abandoned buildings that fall into disrepair and blight making them prime locations for reclaiming lumber (Clinton County Land Bank, n.d.; Ingham County Land Bank, 2015; State Land Bank Authority, n.d.; Walkotten, 2019). Abandoned urban structures become a hazard to the community and are often torn down or demolished with heavy equipment and crushed until they are fit for little but burial in a landfill (Ingham County Land Bank, 2015). This results in a significant quantity of bulky construction and demolition (C & D) waste disposed of in landfills (LaMore, n.d.; Rios et. al., 2015). Table 1 below shows the amount of C & D waste disposed of in Michigan (Michigan Department of Environment, Great Lakes and Energy, 2020 and 2021; Michigan Department of Environmental Quality, 2015, 2016, 2017, 2018, and 2019). While only comprising between 11-17 % of the waste disposed of in Michigan over the last seven years, C & D waste increasingly takes up a significant amount of landfill space and wastes valuable resources that could be reclaimed. Based on an estimate of 233 jobs created per million tons of C & D recycled annually, establishing a market for building materials in Michigan could potentially create approximately 792 jobs per year if all the C & D waste that was disposed of in Michigan in 2020 was recycled (Walton, 2019). If even 10 percent of the C & D waste from 2020 was recycled rather than disposed of, it could create approximately 79 jobs per year (Walton, 2019).

Table 1

Construction & Demolition Waste (C & D) Disposed of in Michigan (Michigan Department of Environment, Great Lakes and Energy, 2020 and 2021; Michigan Department of Environmental Quality, 2015, 2016, 2017, 2018, and 2019).

Fiscal Year	Total Solid Waste from Michigan Disposed of in Michigan Landfills (cubic yards[1])	Total C & D from Michigan (cubic yards)	Percentage (%) of C & D Waste Disposed
2020	40,386,639	6,840,624	17%
2019	43,324,503	6,739,659	16%
2018	39,932,328	5,657,610	14%
2017	37,723,925	4,775,030	13%
2016	37,514,517	4,995,646	13%
2015	36,654,000	4,202,504	11%
2014	36,394,323	4,510,264	12%

[1] Michigan requires landfills to report in cubic yards. For municipal solid waste (MSW) a conversion factor of 3 cubic yards to 1 ton is used. For construction & demolition waste (C&D) a conversion factor of 2 cubic yards to 1 ton is used.

Four studies have looked at deconstruction markets and economic feasibility in the Midwest and Michigan in particular (Delta Institute, 2015; Delta Institute, 2019; Michigan State University Center for Community and Economic Development & West Michigan Shoreline Regional Development Commission, 2017; Walton, 2019). These studies have shown that deconstruction is a feasible strategy to manage end-of-life building materials in Michigan and in particular, in Michigan's Capital Region (Region) consisting of Ingham, Eaton, and Clinton Counties (Delta Institute, 2015). Reuse of building materials has the potential to create jobs, promote Regional self-sufficiency, and create a Regional market for these materials (Delta Institute, 2015). However, a lack of retail outlets in the Region along with a lack of awareness of reclaimed wood and other building materials have been barriers to this solution (Delta Institute, 2015). On average there are 59 homes available yearly in the Region for deconstruction, most of these are in the City of Lansing (Delta Institute, 2015). Consistent with lumber recovery rates from deconstruction projects elsewhere in Michigan of 4 board feet of lumber per square foot of home, and based on the average size of these homes of 1,198 square feet, an estimated 321,000 board feet of lumber, flooring, and trim could be recovered (Delta Institute, 2015). Additionally, 88% of these homes are valuable pre-1940 construction giving this reclaimed wood an estimated retail value of $494,988 (Delta Institute, 2015).

Recovering building materials, rather than burning or burying them, will provide carbon storage and economic benefits. Burning wood releases carbon into the atmosphere and so does the eventual breakdown of wood in a landfill. Recovering wood from urban resources such as tree removals and building deconstruction and material reuse will also help take some pressure off forestlands. Innovative ways of managing forests to respond to climate change and better management of existing timber resources and products are necessary to preserve carbon storage, economic value, biodiversity, and the services provided by forest ecosystems. However, ecosystem changes as a result of climate impact are complicated. These changes may include changes in temperature, length of the growing season, moisture available, biodiversity, and greater disturbances from wildfires, pests, diseases, and extreme weather, and will necessitate changes in how forests are managed (Abatzoglou & Williams, 2016; Bonan & Doney, 2018; Duveneck & Scheller, 2016; Kerr et al., 2016; Stevens-Rumen et al., 2018; Wang et al., 2012). More complex models are being developed for examining how current forest management practices can be changed to maintain ecosystem services and biodiversity and respond to the changing climate (Bonan & Doney, 2018; Duveneck & Scheller, 2016; Stevens-Rumann et al., 2018; Wang et al., 2012).

Additional research is needed on the C & D waste stream, including how reuse of wooden materials can potentially increase carbon sequestration, and mitigate climate impacts and impacts on forests (Bratkovich, 2009; Galvin et al., 2020). Carbon and economic models also suggest the need for further examination of timber products, including the end-of-life disposition of residuals from lumber production, urban tree removals, and building removals (Paul et al., 2020; Wang et al., 2013). Deconstruction and reuse of building materials are generally seen as a more environmentally friendly way of dealing with end-of-life buildings than demolition and landfilling the resulting debris but there is little empirical evidence to back up these claims (Bratkovich et al., 2009; Falk & McKeever, 2012; Galvin et al., 2020; MacFarlane, 2009; Morgenroth et al., 2020; Nowak et al., 2019; Zahir et al., 2016). Additional research could help provide the needed data to support these claims. Deconstruction and reuse of materials also face a few challenges, specifically that they are more costly and time-consuming than

demolition, and it is difficult to establish markets or markets are lacking (Anuranjita et al., 2017; Tatiya et al., 2018; Zahir et al., 2016). So additional research in these areas is also needed to support the development of this market by determining the overall life-cycle and environmental costs of this approach to managing building materials.

Complex problems need complex, multi-disciplinary solutions. Possible solutions to managing end-of-life building materials require examining innovative and sustainable approaches through deconstruction, salvaging, and the reuse of building materials. Continued research is needed to understand all the issues facing forests and how management throughout the life cycle of the materials taken from forests impacts biodiversity, climate patterns, and ecosystem services. By considering end-of-life management of materials first, we can design the construction of buildings in reverse from that point, find better ways to build a structure so the salvage of the materials at the end of a structure's current intended life is maximized and results in improved management of these materials. This can also help provide empirical evidence for why construction companies, materials manufacturers, developers, and consumers should change current materials use and practices, and use or request the use of salvaged materials in their construction projects. Recovering and reusing lumber through a process of deconstruction and salvaging needs to be further studied and quantified to show how this innovative idea can help reduce impacts on the climate and forest ecosystems as well as keep valuable reusable materials out of landfills.

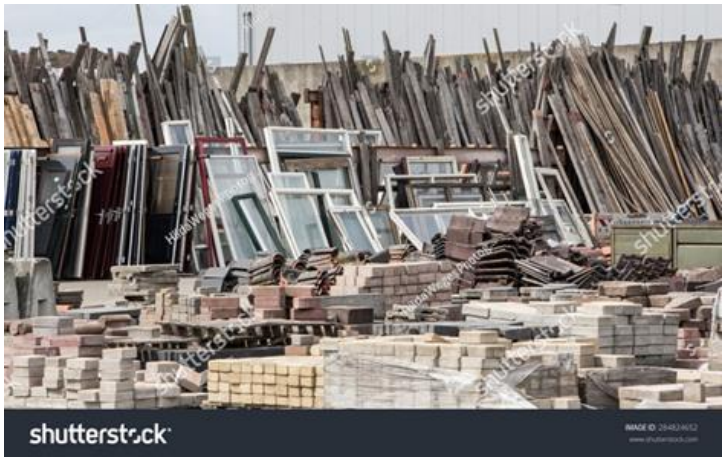

Figure 1: Shutterstock photo of reclaimed building materials.

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