The Timber Industry and Carbon: Summary of Recent Research

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Key Findings:

A. Timber products (lumber, panels, paper) withhold carbon from the atmosphere. The impact is small, though: less than 1 percent of the nation's annual GHG emissions.

B. Some carbon emissions can be avoided when wood building materials substitute for concrete and steel, which have higher emissions per unit. But, many claims about the carbon virtues of wood products overstate the case, by up to 2-to-100 times.

C. Overall, timber production can generate large increases atmospheric carbon, with carbon stored in wood products more than offset by production-related carbon emissions and decreases in carbon stored in forests. In Oregon, the industry's impacts are large enough to exceed the state's automobile emissions.

A. Timber products can store carbon away from the atmosphere, but the impact on climate is small

Claims about the timber industry's contributions to limit climate change have become widespread in recent years. For example:

> "The trees we're building with, as they grow, they're taking carbon dioxide out of the air, and then when the tree's cut at about 10 years old, you build with it and you've just sequestered all of that carbon into the building, [then] new trees grow, they take carbon out of the air, they're cut when they're young — somebody else builds with them, so you're sequestering this carbon in your buildings."[1]

> "Concrete is unsustainable. Timber, however, is the only building material we can grow, and that actually reduces carbon dioxide. Every tonne of timber expunges 1.8 tonnes of carbon dioxide from the atmosphere."[2]

Some of the statements similar to these have no factual basis. Others, though, stem from studies that purport to document the extent to which the timber industry reduces atmospheric carbon. One study, for example, estimated that, in 2000, the U.S. timber industry added 55.8 million metric tons of carbon to the stock of solid wood products and paper (often called harvested wood products).[3] The authors state, though, that this estimate embodies substantial uncertainty.

A more recent study measured the amount of carbon stored annually in harvested wood products and compared it against timber industry's annual GHG emissions (CO_2-equivalent). The result indicates that the U.S. timber industry can, at most, play a minor role in slowing the

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[1] McBride, A. 2019. Wood makes a difference in new six-story office building.

[2] University of Cambridge. 2019. Timber skyscrapers: high-tech 'tree' houses could be he sustainable buildings of the future.

[3] Skog, K.E., K. Pingoud, and J.E. Smith. 2004. A method countries can use to estimate changes in carbon stored in harvested wood products and the uncertainty in such estimates.

emergence of the climate emergency. In recent years, the annual net increase in the accumulated carbon stored in harvested wood products in the U.S. has been equivalent to less than 1 percent of the nation's GHG emissions (Fig. 1).[4] This relationship likely will shrink in the foreseeable future, as current trends show that wood fiber is increasingly used to produce paper, which decomposes and converts stored carbon into atmospheric carbon dioxide faster than fiber used to produce solid wood products.

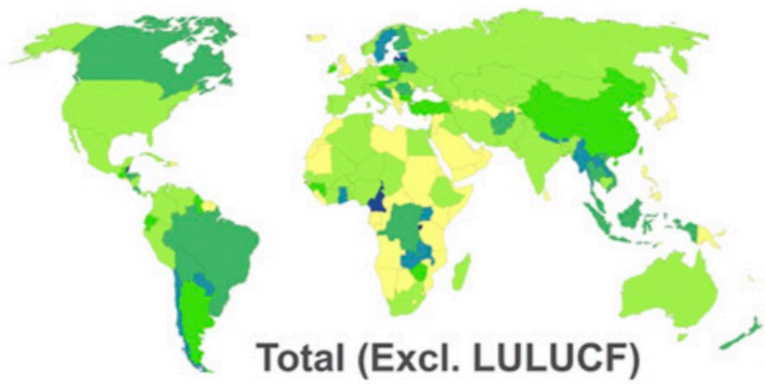

Figure 1. Degree to which annual increments in carbon stored in domestic harvested wood products could offset GHG emissions (excluding land use, land-use change, and forestry). Source: Johnston and Radeloff (2019)

B. Many claims about the climate advantages of substituting wood for concrete and steel rest on analytical flaws

Other studies have focused on the extent to which lumber and wood panels reduce atmospheric carbon by substituting for steel, concrete, and other building materials that have higher levels of embedded carbon per unit. One synthesis of 21 studies found that, when this substitution occurs, wood products containing one metric ton of carbon displace "functionally comparable non-wood products and materials containing 2.1 metric tons of carbon.[5] This section discusses research that challenges the accuracy of these and similar findings.

In 2011, researchers concluded that most studies of the impacts on atmospheric carbon from substituting wood products for building materials, such as concrete and steel, and as a fuel to displace coal, "grossly overestimated" the impacts, with "ambiguous assertions that gloss over forest carbon dynamics."[6] The researchers acknowledged that, "Substitution…can, in theory, result in a fossil fuel offset; for example, when wood replaces a construction material with higher emissions (e.g., concrete or steel)…." One must do more than compare just the amount of carbon on wood vs. the other material. To determine the overall impact on atmospheric carbon, one must consider several additional factors:

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[4] Johnston, C.M.T., and Volker C. Radeloff. 2019. Global mitigation potential of carbon stored in harvested wood products.
[5] Sathre & O'Connor 2010. A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, 2nd Edition.
[6] Law, B.E., and M.E . Harmon. 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change.

- "[C]hanges in the carbon stores of the forest ecosystem have to be considered relative to a base case that includes a lower level of harvests [because] decreasing the interval between harvests, or increasing harvest intensity will lower the carbon store in the forest…."
- "Although there can be some reuse of wood, essentially assuming an infinite lifespan or 100% reuse of wood products is completely unrealistic. Carbon is always lost as wood products are used or disposed of, which means release of CO_2 to the atmosphere."
- "[It is incorrect to calculate the] substitution offset…based on the assumption that each time a house is to be built, [it replaces] nonwood materials. This results in an estimate of the maximum substitution effect possible, but does not account for actual preferences for building materials."
- "[R]eplacing wooden buildings with more wooden buildings results in no additional substitution effect."

One of the researchers just published a follow-up study.[7] He found:

> "Substitution of wood for more fossil carbon intensive building materials has been projected to result in major climate mitigation benefits often exceeding those of the forests themselves. A reexamination of the fundamental assumptions underlying these projections indicates long-term mitigation benefits related to product substitution may have been overestimated 2- to 100-fold."

Others have just recently expressed their concerns about flawed studies that offer support for the notion that logging forests will, somehow, reduce atmospheric carbon:[8]

> "Oliver et al. (2014)[9] acknowledge a balance between intact and managed forest and suggest that long term storage in 'efficient' wood products like wood building materials (with the potential for less carbon emissions compared to steel or concrete, termed the 'avoidance pathway') can offer a significant carbon benefit. To achieve this, some questionable assumptions are that 70% of the harvested wood is merchantable and stored in a lasting product, all unmerchantable wood is removed and used, harvesting occurs at optimum intervals (100 years) and carbon sequestration [by living trees] tapers off significantly after 100 years." [But forestry] models underestimate the carbon content of older, larger trees, and it is increasingly clear that trees can continue to remove atmospheric carbon at increasing rates for many decades beyond 100 years [citations omitted]. Because inefficient logging practices result in substantial instant carbon release to the atmosphere, and only a small fraction of wood becomes a lasting product, increasing market forces and investments toward wood buildings that have relatively short lifetimes could increase forest extraction rates significantly and become unsustainable." [citation omitted]

Looking forward, claims about the climate virtues of substituting wood for concrete and steel must account for efforts to reduce the carbon-intensity of those products. The efforts may markedly diminish, or even reverse climate advantage of wood building materials. New

[7] Harmon, M.E. 2019. Have product substitution carbon benefits been overestimated? A sensitivity analysis of key assumptions.
[8] Moomaw, W.R., S.A. Masino, and E.K. Faison. 2019. Intact forests in the United States: proforestation mitigates climate change and serves the greatest good.
[9] Oliver, C. D., Nassar, N. T., Lippke, B. R., and McCarter, J. B. (2014). Carbon, fossil fuel, and biodiversity mitigation with wood and forests.

technologies reduce the carbon footprint of some concrete products by 70 percent or more, for example.[10]

C. Timber production increases, rather than decreases, atmospheric carbon

When trees are logged, only part of the forest carbon ends up in wood products, and this amount decreases over time (Fig. 2). A common rule-of-thumb for logging of industrial forests is that 65 percent of the live carbon is removed from a forest as logs, and 75 percent of this carbon is converted to wood products.[11] In other words, more than one-half of the carbon is directly emitted through logging and manufacturing.

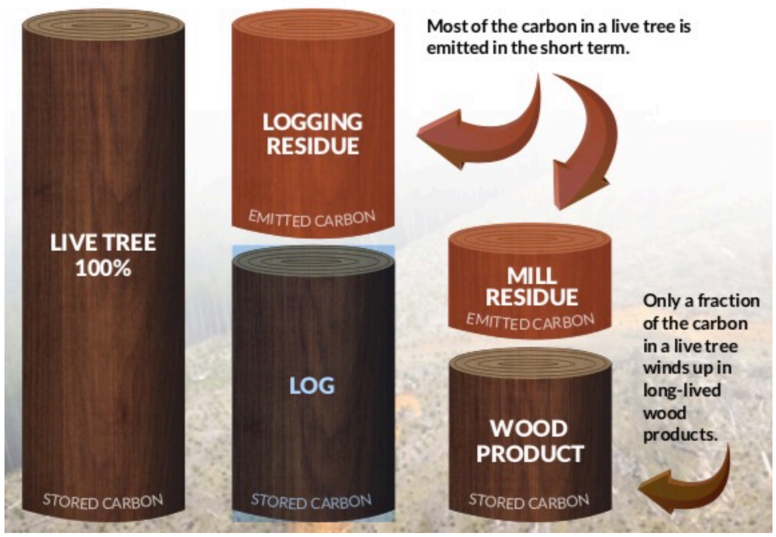

Figure 2 Disposition of forest carbon. Source: Sierra Club (2019)

Research in Oregon has documented the significance of the timber-industry's carbon emissions. Two studies, using different methodologies, found that the industry currently emits about 34 million metric tons of carbon dioxide annually.[12] The industry is the state's source of emissions; the timber generates even more carbon dioxide than the combustion of fossil fuels.

Carbon emissions are even greater when logging occurs on older forests, where larger trees storing larger amounts of carbon. One review of the relevant literature[13] found:

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[10] Petrova, M. 2019. This green cement company says its product can cut carbon dioxide emissions by up to 70%; and Alter, L. 2019. LafargeHolcim is selling CO2-sucking cement for precast, reduces emissions by 70 percent.
[11] Harmon, M.E. (2019).
[12] Law, B.E., Hudiburg, T.W., Berner, L.T., Kenbt, J.J., Buotte, P.C., Harmon, M.E., 2018. Land use strategies to mitigate climate change in carbon dense temperate forests; Oregon Global Warming Commission. 2018. Forest carbon accounting project report; Krankina, O.N., et al. 2012. Carbon balance on federal forest lands of Western Oregon and Washington: The impact of the Northwest Forest Plan; and Talberth, J., 2017. Oregon Forest Carbon Policy: Scientific and technical brief to guide legislative intervention. Portland, OR: Center for Sustainable Economy. Available online at: https://sustainable-economy.org/wp-content/uploads/2017/12/Oregon-Forest-Carbon-Policy-Technical-Brief-1.pdf.
[13] Sierra Club. 2019. Forests, wood & climate.

- "Older forests store more carbon than younger forests."
- "[O]nly a fraction of the carbon in an old-growth tree is actually stored if it is cut and converted to products. Estimates vary, but…less than a third of the original carbon in an individual tree is carried through to the end of the processing chain." [citation omitted]
- "[R]eplacing old-growth forest with a plantation can result in up to a 60% loss of carbon stores that will not be made up over time if, as is typical, the plantation is subsequently logged every 40 or 50 years."
- "Forest management that is less intensive (e.g. smaller clearcuts, more live-tree retention, wider riparian buffers) results in less overall emissions of forest carbon than more intensive management (e.g. industrial tree farms that rely on large, frequent clearcuts and applications of greenhouse gas-emitting fertilizers, herbicides and pesticides)."

Recently completed research[14] reinforced the conclusion that logging results in higher, not lower emissions:

> "[B]iological carbon storage in managed stands, regardless of the silvicultural prescription, is generally lower than in unmanaged intact forests—even after the carbon stored in wood products is included in the calculation." [citations omitted]

These findings support several recommendations:

- "Research indicates that forest carbon is maximized where there are the highest levels of forest protection and the least amount of logging, or no logging at all. Therefore, we should permanently protect those forests that are the most carbon-rich and are mostly found on U.S. federal forestlands." [citation omitted]
- "Afforestation (planting trees in areas where there are none currently and it is ecologically appropriate to do so, e.g. in fallowed fields) is desirable because it brings near-term carbon benefits and will increase wood supply in the long term."

…and these conclusions:

- "A key question is whether forest management and wood use can result in a net increase in carbon stores. Without great advances in forest protection and stewardship, the answer is almost certainly not."[15]
- Timber-related carbon emissions are higher, perhaps far higher, than previously reported for the logging of large, old trees. Therefore, "to increase the overall amount of carbon stored in the system…conversions of old-growth forests in the Pacific Northwest to plantations should be avoided, whereas creation of plantations on old-fields should be encouraged. Moreover, existing plantation systems are unlikely to increase their carbon stores unless building longevity is substantially increased."[16]

The IPCC extended similar findings to the harvesting of forests to provide fuel for generating electricity.[17]

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[14] Moomaw, W.R., S.A. Masino, and E.K. Faison. 2019. Intact forests in the United States: proforestation mitigates climate change and serves the greatest good

[15] Sierra Club. 2019.

[16] Harmon, M.E. 2019.

[17] Smith, P., et al. 2014. Agriculture, forestry and other land use (AFOLU). Chapter 11 in Climate change 2014: Mitigation of climate change. Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Eden- hofer, O., et al. (eds.).

> "...in the specific case of existing forests that may continue to grow if not used for bioenergy, some studies [that assume the forests are logged] show that forest bioenergy systems can temporarily have higher cumulative CO_2 emissions than a fossil reference system...."

In other words, logging a forest to provide biofuels can generate higher carbon emissions than would result from burning coal, oil, or natural gas. Given these findings, the IPCC report concluded:

> "Bioenergy could play a critical role for climate change mitigation, if conversion of high carbon density ecosystems (forests, grasslands and peatlands) is avoided and best-practice land management is implemented…."

Notwithstanding the biophysical evidence that shows timber production has little, if any positive impact on atmospheric carbon, some advocate for timber production as a way to prevent landowners from doing greater harm to the climate.[18], [19]This view concludes that, without an opportunity to earn income from the sale of logs, many forest landowners would convert their lands to non-forest uses that have worse impacts on atmospheric carbon than would occur if the land were used for the industrial production of logs.

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[18] *See*, e.g., Ryan, M.G., et al. 2010. A synthesis of the science on forests and carbon for US forests; and Miner, R.A., et al. 2014. Forest carbon accounting considerations in US bioenergy policy.

[19] Smith, P., et al. 2014. Agriculture, forestry and other land use (AFOLU). Chapter 11 in Climate change 2014: Mitigation of climate change. Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Eden- hofer, O., et al. (eds.).