YALE FOREST FORUM
SPEAKER SERIES SUMMARY

YFF Review

The Future of Wood Building Products in a Changing Climate: The Case of Mass Timber

September 9 to November 18, 2021
New Haven, Connecticut, USA

The Forest School at the Yale School of the Environment

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Front cover photo: Wood Innovation and Design Center, Michael Green Architecture. Photo courtesy of Ema Peter.

The Forests Dialogue hosts forest stakeholders from all over the world in Finland to study mass timber, tracing the supply chain from the forest to completed building. Photo by Samuli Skantsi.

YFF Review

YALE FOREST FORUM AND *YFF REVIEW*

The Yale Forest Forum (YFF) is the convening hub of The Forest School at the Yale School of the Environment. YFF offers weekly webinar Speaker Series during the academic year to provide opportunities to hear from leaders in forest management, conservation, academia, and policy. Each YFF Speaker Series is organized around a key theme or challenge facing forests, forestry, and people. Guest speakers represent a wide range of perspectives and organizations, including government, NGOs, and businesses, and across scales from local to international. The *YFF Review* is a publicly available output of the series, summarizing key learnings and examples from the YFF Speaker Series.

Mass timber components are used to build Common Ground High School in New Haven, Connecticut. Gray Organschi Architecture/Bensonwood.

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The roof of the Event Centre Satama in Kotka, Finland is one of the largest roofs using mass timber components. Photo by Gary Dunning.

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Introduction

By: Luca Guadagno

The Yale Forests Forum has been engaging people on the most important issues in forestry since 1994. In the fall of 2021, YFF brought together more than 1,000 registered attendees from around the world to hear from eleven experts and leaders working across the mass timber value chain, representing forestry, industrial ecology, architecture, conservation, and academia. Emerging discussions around utilizing mass timber to aid in efforts to decarbonize the building sector and improve forest management spurred interest in highlighting expert opinions and ongoing research on mass timber. In this series, speakers discussed the role forest products can play in addressing climate, resource, societal, and environmental challenges. They explored the environmental, economic, and societal implications associated with using forest products like mass timber.

Mass timber is a class of engineered wood products including cross-laminated timber (CLT), glued-laminated timber (GLT), laminated-veneer lumber (LVL), and mass plywood. These strong yet relatively lightweight products are made by aggregating and layering pieces of wood to create load-bearing elements for use in a range of construction applications—including in the construction of mid-rise buildings. Europe has the largest number of buildings made with mass timber components. Interest is on the rise globally with an increasing number of structures in North America and ongoing efforts to expand the practice in South America, Africa, and Asia.

The speakers from this YFF series shared a range of perspectives on the potential impacts that increasing mass timber use might have on forests, communities, and global carbon budgets. An entry point for many was the potential for mass timber to aid in decarbonizing the building sector, responsible for nearly 40% of global emissions according to estimates from the United Nations Environment Program's 2020 Global Status Report for Buildings and Construction. In his talk, Mark Wishnie outlined three levels

Adohi Hall, mass timber residence at the University of Arkansas.
Photo courtesy of Timothy Hursley/Leers Weinzapfel Associates.

of potential climate benefits of mass timber: increased carbon sequestration in living trees managed to produce wood products, carbon storage in durable wood products themselves, and a substitution benefit when mass timber is used instead of more resource-intensive materials. When sourced from sustainably managed forests with appropriate social and ecological safeguards, mass timber has the potential to deliver ecological and social benefits, too. As the team from The Nature Conservancy shared in their talk, assessing the sustainability of wood building materials involves complex, interdisciplinary research and analyses of a range of social, ecological, and climate factors.

Impacts of mass timber products will differ across the globe as Ana Bastos and Mokena Makeka further illuminated while sharing challenges and opportunities of mass timber building materials. Regionally, these impacts can vary greatly, depending on local construction trends, forest management conditions, and manufacturing capabilities. Speakers Yuan Yao and Niko Heeren discussed advances in industrial ecology research which enable comparisons of mass timber products with conventional building products and how this impacts sustainability metrics across use scenarios. The series concluded by highlighting forward-thinking architects and designers whose work examines mass timber's role in sustainable development, urbanism, and future cities. Whether presenting new research on wood products' embodied emissions or the design plans for a mass timber structure, every talk in this YFF series exposed audience members to the cutting-edge ideas and research at the forefront the rapidly evolving field of mass timber construction.

"The Future of Wood Building Products in a Changing Climate" YFF Speaker Series was jointly hosted by The Forests Dialogue, the Center for Industrial Ecology at the Yale School of the Environment, and the Yale School of Architecture. The Forests Dialogue was created in 2000 to provide a platform for leaders in forestry from across the world to engage in dialogue about and develop solutions to the most pressing issues in sustainable

Adohi Hall, University of Arkansas. Photo courtesy of Tom Chung/Leers Weinzapfel Associates.

forest management. The Center for Industrial Ecology was established in 1998 and designed to bring together Yale staff, students, visiting scholars, and practitioners to develop knowledge at the forefront of the field of industrial ecology. The Yale School of Architecture is a graduate professional school at Yale University that trains undergraduate, masters, and doctoral students in architecture.

All materials referenced in this document including bios for speakers, readings, and webinar recordings can be found at the Yale Forest Forum Website.

Mass timber structural element being produced.
Photo courtesy of Alan Organschi.

Solid Wood Products of Tomorrow: A Case for Mass Timber

September 9, 2021

Steve Marshall

STEVE MARSHALL, *Founder*
MASS TIMBER STRATEGY

By: Jennifer Kroeger

In his presentation, "Solid Wood Products of Tomorrow: A Case for Mass Timber," Steve Marshall reflected on the changes he has observed in the mass timber space over his career working in federal and private organizations advancing mass timber innovation in the United States, most recently in his role as the founder of Mass Timber Strategy. Marshall's talk focused on why mass timber matters and opened with him highlighting the need to decarbonize our built environment.

In the 21st century, there is a pressing need for scientists, policymakers, industry, and individuals to work together to find solutions to decrease CO_2 emissions and sequester carbon in order to slow climate changes that threaten our environment. Building infrastructure in America represents a critical environmental opportunity; approximately 40% of CO_2 emissions in the United States are attributed to building operation and construction. Building operation, such as heating and cooling, is the primary cause of these emissions, but buildings also incorporate "embodied carbon", which is the amount of emitted carbon associated with the actual construction of the building. Although energy use intensity in buildings is expected to decrease with more efficient technologies, overall emissions are expected to grow, as floor areas of commercial operations are predicted to rise by at least 33% by 2050. This increase does not account for additional increases in residential building space. Utilizing mass timber for commercial and residential construction material is an opportunity to decrease building-associated emissions. In addition to decreased emissions, co-benefits, including decreased disturbance during construction and health benefits from biophilic design, stand to improve the lives of citizens working and living in mass timber environments.

In choosing whether to build with wood or concrete and steel, builders face the decision of using renewable or fossil-based resources. As Marshall put it, mass timber operates as a "solar powered construction material" that can be replenished within the course of decades, whereas limestone used for concrete takes millions of years to replenish. Structural steel utilized alongside concrete accounts for over 50% of world steel consumption, the manufacturing of which resulted in over 3.4 billion tons of Co_2 emitted in 2020. By building with mass timber, new infrastructure's embodied carbon can effectively be zeroed-out, with the timber functioning as a carbon-storing material.

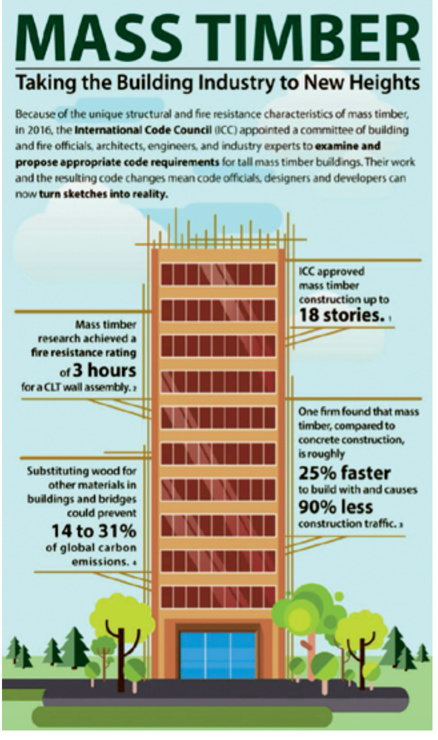
Olver Design Building at the University of Massachusetts Amherst under construction. Photo by Alex Schreyer.

Cross-laminated timber is made from boards that have been glued together at opposing angles to increase strength. Photo courtesy of Steve Marshall.

But what is mass timber? Mass timber is a framing style in which pieces of lumber have been combined together methodically to a create strong, light weight building product. The most popular type of mass timber is cross-laminated timber (CLT), which are large timber pieces made out of smaller wood boards that have been glued together at opposing angles to increase strength. Other popular mass timber products do not necessarily have the same strength as CLT with its opposing angles, but function well with other arrangements of combined wood boards. In glue-laminated timber (GLT), also known as glulam, boards are glued parallel to each other, and in nail- and dowel-laminated timber (NLT and DLT), parallel boards are similarly combined with nails and dowels, respectively. Many more mass timber products exist and are being designed as the product market increases, including hybrid products that incorporate both mass timber and steel.

The attractiveness of mass timber extends beyond the sustainability of the product itself. Mass timber builds are approximately 25% faster than traditional concrete construction projects and require 75% fewer crew members. This decreases truck traffic by up to 90%, creating a quieter and less disruptive construction environment in local communities. Mass timber projects can also be built upon existing concrete foundations, effectively recycling these existing structures. Additionally, biophilic design that incorporates natural elements (in this case, wood interiors) is a style argued to increase the health and wellbeing of those who utilize the spaces. The presence of natural elements in a living or working space has been found to provide psychological restoration and foster stress relief, too.

The benefits of mass timber building within the current sustainability-focused market create momentum for the greater adoption of mass timber construction and for policies that encourage mass timber production and use. The mass timber industry began in the 1900s in Europe, but until 2013, almost no CLT or other mass timber production occurred in North America. In 2021, over 1000 projects are being designed and built across the United States and over a dozen production facilities exist in North America. Changes to building codes and government investment strategies work in tandem to drive this market forward. For example, as of 2021, international building code allows for up to 18 stories of mass timber and many cities pre-adopted this new code to begin builds before it officially took effect. Eight states have also put forward proposals to prioritize embodied carbon investments, which would create another economic incentive for mass timber construction. Just as new policies promote its usage, new technologies measuring mass timber's carbon sequestration and emissions sustainability will drive its popularity.



American Wood Council (AWC) Codes and Standards for mass timber. Image by the American Wood Council.

Momentum for mass timber relies on ever-changing building codes, the supply and price of many types of products, tools to measure its benefits, and government support of these benefits. Immediate goals of the mass timber industry are building taller structures to demonstrate mass timber's capabilities, and to provide more examples of infills and overbuilding additions to existing buildings. Continued testing of mass timber products against wood shrinkage and expansion, seismic activity, and extreme weather will also increase trust in the product and inspire new usages. These structural tests and examples of successes will help to address the largest challenge that currently exists in the mass timber industry, which is simply familiarity. More exposure to successful projects will convince the markets that investment is worthwhile and grow reliable support for new projects. As these gaps in knowledge and support are filled, solid wood infrastructure will reach new heights, figuratively and literally, across the American construction industry.

John W. Olver Design Building under construction. BCT.
Photo by Alex Schreyer.

Climate Impacts of Timber Construction

September 16, 2021

GALINA CHURKINA, PhD, *Guest Senior Scientist*
POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH


Galina Churkina

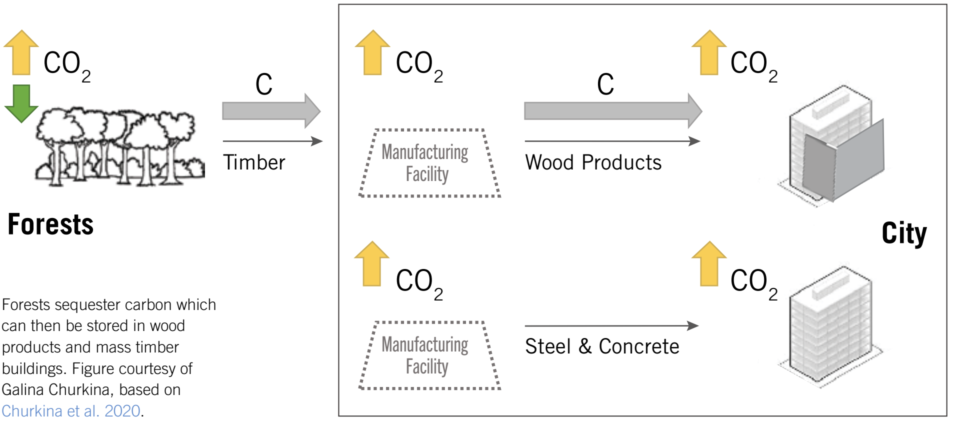
By: Josh Greene

In her presentation, Galina Churkina, quantitative biologist and incoming professor of urban ecosytem sciences at Germany's Technische Universitat Berlin and a quantitative ecologist, offered a strategy to mitigate the current global climate crisis by substituting the large-scale use of mineral-based building materials with biogenic materials in current and future inner cities. Her talk expanded on ideas presented in her recent study, *Buildings as a Global Carbon Sink*, promoting the engineered sequestration of carbon in cities. Churkina centered her lecture around the fundamental relationship between forests and the city, with the manufacturing facility functioning as a critical threshold in between the two disparate elements. Churkina positioned the forest as the largest source of potential carbon management conflict. She explained forests' significance as a carbon sink, importance in the water cycle, and ability to modify heat fluxes. By properly managing the forest in an environmentally productive manner, Churkina asserted that timber construction has the potential to be a powerful agent in the fight to mitigate climate change.

Throughout her talk, Churkina presented two groundbreaking case studies that get at the core of these fundamental questions. First, she asked: What are the effects of 250 years of forest management and timber extraction in Europe? This time period saw an increase in afforestation, a decrease in unmanaged forest areas, and an increase in conifer trees. In total, these actions did not cool the European climate, but rather increased summer temperatures and increased the radiative imbalance of the atmosphere. In the presentation of this case study, Churkina impressed upon the audience that we need to account for various processes and sequestration techniques in order to combat the global climate crisis.

The second case study positioned how the transition to urban timber buildings could be extremely powerful in mitigating climate change, rather than being a climate liability. With an expected 2.3 billion new urban residents by 2050, the demand for new housing, commercial buildings and accompanying infrastructure will greatly increase. Churkina laid out three alternative scenarios to the current trend of construction with steel, concrete, and business as usual: shifting 10%, 50%, or 90% of new buildings to timber construction with innovative new engineered wood products, or "mass timber." Churkina concluded that the transition to urban timber buildings can reduce CO_2 emissions from material manufacturing and construction by half, store 0.01-0.68 Gt C per year in cities, and create an urban carbon pool of up to 20 Gt C over 30 years. In addition, Churkina called for a greater diversity of tree species to be used in mass timber in order to combat the impacts of forest disturbances like droughts, pests, and fires while working with the timber industry.

Churkina concluded that timber construction's impacts on climate are manifold. She presented a lifeline for the building industry to meaningfully combat our global climate crisis as the industry scales up. Prioritizing a carbon pool in timber cities emerges as an obvious benefit and a critical need that can stimulate the sustainable management of forests. As the demand for sustainably sourced timber increases, we must equally monitor the forest carbon pump, adapt mass timber manufacturing to a changing climate, and diversify timber inputs and outputs essential for maintaining the relationship between the forest and the city.



Forests sequester carbon which can then be stored in wood products and mass timber buildings. Figure courtesy of Galina Churkina, based on Churkina et al. 2020.

Tomorrow's World: Future Forests, Timber Supply, and the Bioeconomy

September 23, 2021

MARK WISHNIE, *Head of Landscape Capital and Chief Sustainability Officer*
BTG PACTUAL TIMBERLAND INVESTMENT GROUP

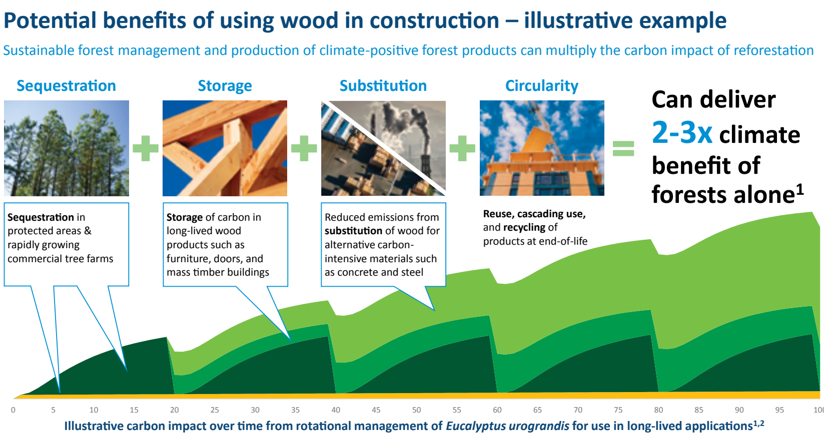

Mark Wishnie

By: Isobel Campbell

Mark Wishnie, head of Landscape Capital and chief sustainability officer at BTG Pactual Timberland Investment Group, brought an investment perspective to the potential of wood as a renewable resource in mass timber products. Mass timber encompasses timber composites, such as cross-laminated timber (CLT), which can replace concrete and steel as structural components in construction. Wishnie is a proponent of forestry and mass timber to transition the world towards net zero emissions; in his talk he pointed toward the enormous opportunity to harness the vast capital used for commercial reforestation and use it to find synergies that are also climate solutions.

It is estimated that natural climate solutions (NCS) could achieve 37% of the cost-effective CO_2 mitigation needed by 2030 to keep warming below 2°C. Forests make up 73% of potential contributions to this approach, far outweighing techniques such as soil carbon sequestration and wetland restoration. However, this will require reforestation of over almost 500 million acres, equivalent to doubling U.S. timberland acreage in 10 years.

This scale of change will require significant investment. Carbon offsets are commonly highlighted as a forest financing mechanism; however, Wishnie emphasized that the size of the offsets industry ($0.47B) pales in comparison to the timber and forest sales industry ($366B). This presents an opportunity for the private sector to drive NCS through forestry.



Wood-based construction results in 2-3 times the climate benefits of forests alone. Figure by Leskinen et. al, 2018, TIG Analysis with photos by Getty Images, Pollux Chung / Seagate Structures.

So how can the timber and forest products industry provide climate benefits?

1. **Sequestration:** Rotational planting cyclically sequesters a higher base level of carbon in forests compared to alternative agricultural land uses.

2. **Storage:** Harvested timber stores carbon in long-lived wood products such as furniture and mass timber.

3. **Substitution:** Substituting mass timber for carbon-intensive construction materials such as concrete and steel reduces emissions. The growing construction industry currently accounts for 11% of global carbon emissions.

Combined, these applications can deliver 2-3 times the climate benefits of a forest that is never harvested. As such, the timber commodity market presents a funding mechanism and an opportunity to reduce climate impacts.

CAPITAL OPPORTUNITIES

As awareness of climate change's threats grows, commitments to zero emissions are increasing, with pledges by organizations such as Microsoft, Amazon, and Shell. The capital committed to achieving net-zero emissions by 2050 stands at $43 trillion, dwarfing the current 49 billions of dollars of capital investment in forests. As a commodity, mass timber offers a return on investment. Thus, it presents an enormous opportunity to capitalize on some of the funds earmarked for low emissions projects while providing significant climate benefits.

LIFECYCLE IMPACTS OF MASS TIMBER

Mass timber has significant potential climate benefits; however, it is critical to analyze the entire lifecycle and impacts on carbon stocks to ensure that net benefits are positive. In terms of carbon sequestered in forests, this will involve monitoring reforestation and rotation length trends to avoid deforestation and degradation. Similarly, when considering the substitution of concrete and steel with mass timber, it is essential to evaluate the entire lifecycle emissions ranging from timber processing to installation to maintenance.

WOOD SOURCE

A legitimate concern about increasing mass timber is the possible impact on global forest stocks. There is evidence that increasing forestry revenues and demand for forest products is strongly correlated with reforestation and increased standing stock in forests in the U.S. Essentially, with increased demand comes increased supply. Currently, planted forests account for only 7% of forests globally but produce 50% of wood products.

In addition, from 2000-2015, forest wood products accounted for only 2.5% of commodity-driven deforestation, with conversion to agricultural land the predominant cause of deforestation. The risk posed by mass timber should not be ignored; however, Wishnie believes we can have confidence that mass timber will not

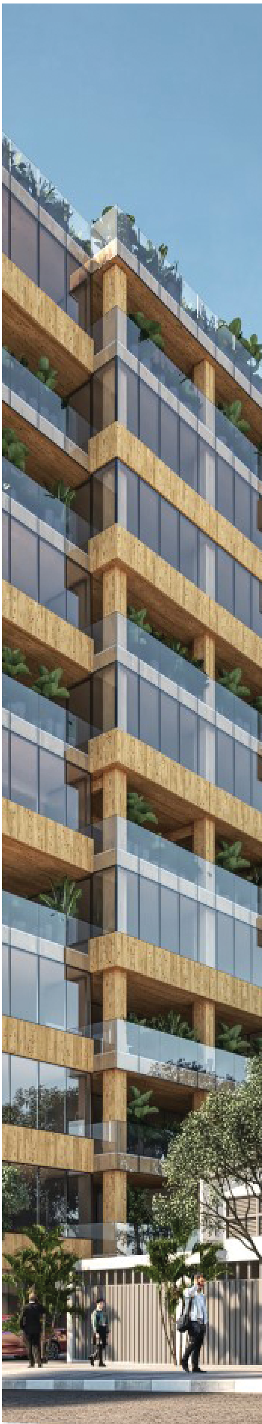
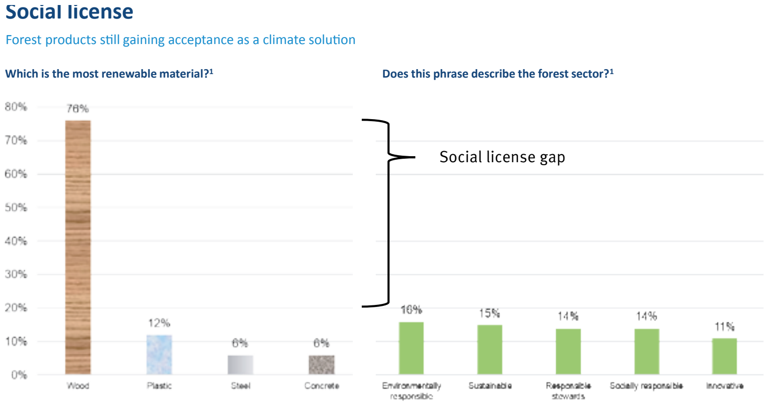


Image courtesy of Noah Wood Building Design.

accelerate an existing driver of deforestation. Sustainable forestry must be guided by certifications and standards, such as the Forest Stewardship Council (FSC), which operates in over 80 countries.

SOCIAL LICENSE



Mass timber has an enormous capacity to deliver climate benefits; however, public support will be critical to achieving this. In a survey in North America, 80% of respondents identified timber as the most renewable material; yet, when queried about the forestry sector, respondents deemed the industry a “bad actor” with concerns over environmental performance and social responsibility. This disparity between public perceptions of wood products and the industry producing them could be problematic. If mass timber is to expand, the sector will need to be mindful of public perceptions to ensure ongoing social license to operate.

In conclusion, forestry has significant potential as a natural climate solution, offering benefits through carbon sequestration, long-term storage in wood products, and reduced construction emissions. If challenges such as lifecycle impacts, sustainable wood sourcing, and social license are addressed appropriately, the mass timber market could be a powerful lever in this transition, capitalizing on the substantial capital available for net-zero emissions projects.

The Brazilian Forests and the Mass Timber Market

September 30, 2021

ANA LEITE BASTOS, *CEO*
URBEM


Ana Leite Bastos

By: Zexi “Cicy” Geng

Ana Leite Bastos, the CEO of Urbem, a spinoff of AMATA, Brazil, brought the Yale Forest Forum to the Brazilian forests. Bastos presented her vision of mass timber and engineered wood technology as an entrepreneurial opportunity in Brazil and South America. AMATA has been in operation for 15 years and is dedicated to best practices in forest management and timber utilization. Intending to engage innovative market trends, AMATA brings pioneering materials and building assembly technologies – now most notably mass timber – to the construction sector in Brazil. The new spinoff company, Urbem, targets the building construction market with a conviction that forests are a powerful and robust ecosystem that can supply products to sustainably build the cities of the future. They believe “good forestry” can prevent deforestation, protect the Brazilian biomes, restore degraded lands, and transform the construction market to become more sustainable.

Brazil is known for its forests. The Brazilian Amazon is located in the northern region of the country, providing habitats for 30% of fauna and flora species in the world, according to Geng. However, fires and logging have threatened ecosystem health. AMATA sees the potential for sustainable native forest management and opportunities to restore these largely degraded areas with productive commercial trees. AMATA produces and manages sustainable pine forests in Paraná, one of the most degraded regions in Brazil. The plantation establishes ecological corridors to improve local habitats and biodiversity, enhances soil nutrients and productivity, and increases carbon stocks.

Currently, wood production from planted forests makes up about 7% of Brazilian GDP and occurs on 80 million hectares. Even though Brazil already has a robust capacity to produce wood products from the planted forest sector, wood production is likely to expand because the land in need of recovery is twice the size of the area of reforested lands. Currently, eucalyptus and pines are planted commercially in Brazil. The harvest cycle for planted pines is sixteen years in Brazil. The short growth period is due to the high site productivity, making Brazilian pines competitive in quantity, quality, and cost in the global market.

Urbem saw an opportunity for growth in the mass timber market for Brazil and South America as the demand for the products grew in North America, Asia, and Australia. Though in principle native wood species have the potential to contribute to mass timber production, more research and technology would be needed. Urbem plays it safe and uses pines, the most researched timber trees, as their mass timber species of choice.

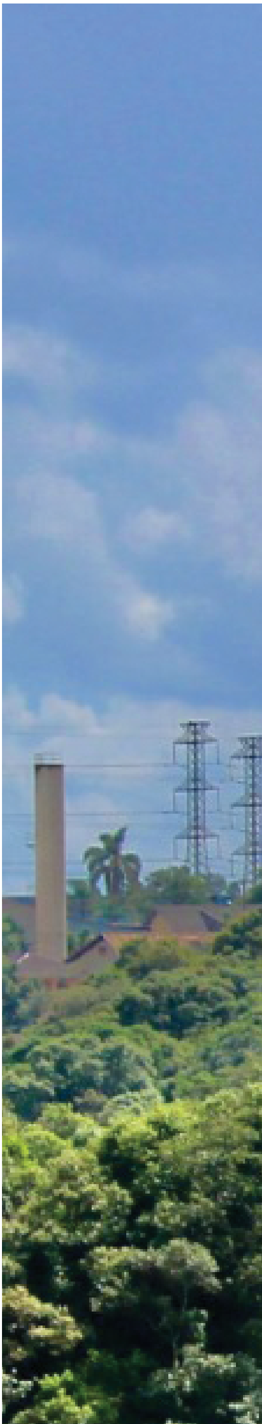
Urbem mass timber factory in Paraná, Southern Brazil.
Photo courtesy of Urbem.

The construction market is of considerable size in Brazil. The building stock grows by about 180 million square meters every year, according to the statistics from 2018. Bastos and her team observed a market shift toward sustainable and high efficiency in the past 18 months. As previous Yale Forest Forum speakers have discussed, mass timber technologies – including CLT and glulam – have a very high potential for efficient carbon storage. Perhaps more importantly, mass timber is more time and resource efficient because of high-precision cutting, less construction time, and less risk exposure. Thus, there is a strong potential market for locally manufactured CLT and glulam in Brazil and other parts of South America.

The Urbem factory is located in Paraná state in the south of Brazil. Paraná has plantations that comprise 80% of pine production in Brazil, making the location suitable for sourcing raw material for the manufacturing of mass timber. In addition, the factory is close to other large markets (i.e., Sao Paulo, Santa Catarina, and two main ports: Paranagua and Itajai). The two ports could potentially enable further exportation to other growing and transitioning markets. The factory is estimated to begin operation in the second half of 2022.

Urbem works closely with the following stakeholders: the Brazilian National Standards Organization (NBR) for approval of mass timber utilization in building construction, the Brazil Fire Department for mass timber education, and different financial institutions for financial products and support. Urbem also seeks a third-party, global certification to validate their products, including U.S. and European product certification, Forest Seal from the Forest Stewardship Council, and Certified B Corporation which recognizes positive social and environmental impacts of for-profit companies.

The mass timber business is a challenging but viable one for Urbem, with a potential to expand into other regions in South America. In Brazil, existing, in-construction, and planned mass timber projects include:



Urbem mass timber factory in Paraná, Southern Brazil.
Photo courtesy of Urbem.

- **Shop Dengo, São Paulo:** a three-story, 1500 square meter chocolate factory, constructed with 100% CLT and glulam.
- **E-wood, São Paulo:** an eight-story office and institutional use building, conceived of by the general contractor HTB and planned to be constructed with hybrid structures of CLT, glulam, and reinforced concrete.
- **Noah Offices, São Paulo:** a ten-story new project, expected to finish in 12-18 months.

Overall, Urbem demonstrated that mass timber production in Brazil is a viable business in the building construction market. It makes positive impacts by practicing sustainable forestry and storing carbon in the buildings. We look forward to Urbem's first large-scale mass timber factory taking off in 2022.

Digital rendering of Noah Offices using mass timber construction in São Paulo, Brazil.
Image courtesy of Noah Wood Building Design.

Building It Right: Understanding Potential Forest Impacts from Mass Timber Construction

October 6, 2021

RACHEL PASTERNACK, *Senior Advisor for Natural Climate Solutions*
ETHAN BELAIR, *Natural Climate Solutions Forester*
THE NATURE CONSERVANCY (TNC)

By: Thomas Harris


Rachel Pasternack


Ethan Belair

The Nature Conservancy, a global organization with over 125 million acres of forests protected and 400 scientists on staff, joined the Yale Forest Forum to share their ongoing work investigating how increases in mass timber production could affect forests, as well as potential safeguards to mitigate negative impacts. In their talk, Rachel Pasternack, senior advisor on natural climate solutions, and Ethan Belair, natural climate solutions forester, highlighted how nature plays a role in climate change mitigation. Joining them was Yangyang Wang, research forester for natural climate solutions, and Caitlin Clarke, senior conservation fellow, supply chains. Although human communities have depended on wood for centuries to construct our built environment, a suite of emerging wood products under the mass timber umbrella promises to take that construction to new heights.

In the U.S., mass timber construction is allowed up to 18 stories tall, but in other countries, taller skyscrapers built out of wood are being proposed and built. With this new building style comes the potential to offset the embodied carbon cost of producing and delivering steel and concrete used in traditional buildings of this size. It is well understood that trees pull carbon from the atmosphere as they grow and develop in the forest. By sustainably harvesting those trees and converting them into durable wood products, architects and builders have the chance to store that carbon in the form of mass timber structures in the built

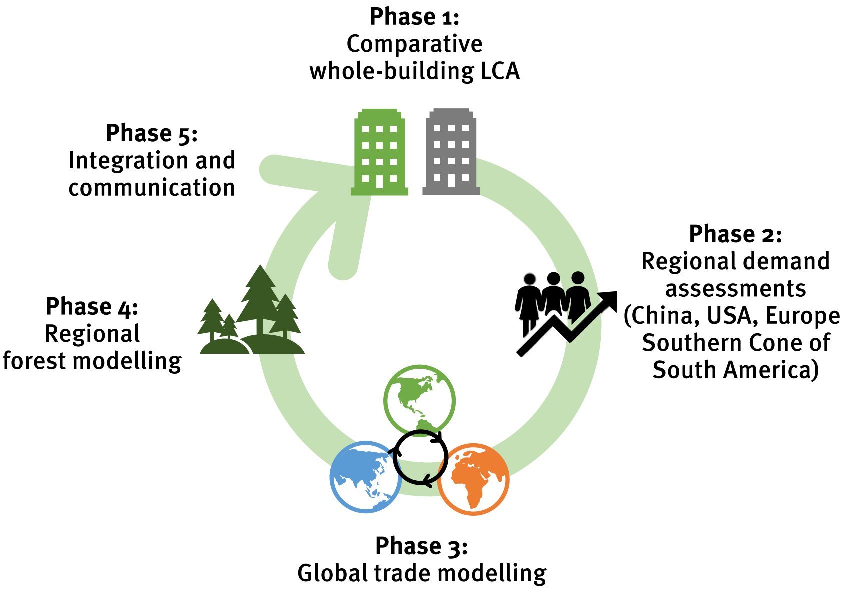
environment. However, as Ethan pointed out during the talk, with the possibility of increased demand for wood in mass timber construction, the volume and area of forest harvesting may also increase. The suite of benefits provided by working forests is complemented with the long term storage of carbon in building materials. With this in mind, the objective of TNC's talk was to expand and connect how this process can be carried out in mass timber construction and the potential impact it will have on the forest landscape.

The collaborative work of TNC's Natural Climate Change Implementation Team centers around 4 key steps in the forest products value chain:

1. **Sequestration:** Trees grow and incorporate carbon into their tissues. The organic process of forest growth supports the global ecosystem and provides the basis for materials our society depends on.
2. **Substitution:** Humans use wood or mass timber in place of other building materials (e.g., steel and concrete). This substitution decreases energy inputs needed, transportation demands, and construction time when wood is used as a building solution.
3. **Storage:** If mass timber is used in a building, there is the expectation that it will be stored there for as long as the building stands. This storage time locks the carbon in wood products while new trees in the forest continue to grow and sequester carbon.
4. **Auxiliary climate benefit:** The assembly of mass timber utilizes smaller trees than many traditional wood products and creates the opportunity to improve active forest management. This in turn creates the opportunity to generate economic benefit throughout the supply chain while providing more climate benefit compared to traditional forest management.

The Ascent MKE building in Milwaukee, Wisconsin, with 25 stories at 87 meters tall, is the tallest high-rise building using mass timber components along with some steel and concrete. Photo by SidewalkMD

In their presentation, the speakers pointed out that some models indicate that carbon benefits of substitution and storage can be three times greater than the sequestration benefits of growing trees alone.



Five phases of the global mass timber impact assessment (GMTIA).
Figure by Pasternack et al. 2022.

To disentangle this complex system of production and building, TNC's team and collaborators are working to quantify the,; potential impact of increased demand for mass timber on the forest products market and greenhouse gas emissions globally. The speakers outlined the project's five distinct phases (See figure), starting with the completion of a comparative life cycle assessment (LCA) that took a complete and comprehensive look at the way mass timber can be used. The hope is that mass timber offers multiple benefits across the value chain, from the growth of trees to the construction of new buildings that will embody carbon. In addition, that LCA is coupled with regional demand assessments, global trade modeling, and regional forest modeling. The final step of integrating and communicating this analysis is still being completed.

The presenters shared that the next step in the LCA is to describe the effect of scale on the benefits for mass timber, pointing out to the audience that bigger doesn't necessarily mean better. The variation in building codes and timber supply from different regions led the team to analyze those impacts on the LCA. They chose three cities and three different sized buildings to compare. By including those additional variables, their impact on total wood used in a building, and the total carbon stored in that wood, the calculus gets more complicated. Depending on building design and products used, smaller mass timber buildings can at times store more carbon than larger ones.

Regional variation is more pronounced on a global scale where the sources and users of wood are quite different. Modeling the flow of wood between countries and coupling that with the expected demand for mass timber can help estimate how the new building challenges can be met with mass timber design. Preliminary results showed that adoption of mass timber may increase softwood harvest by approximately 2%, though that varies between regions.

To meet the increased demand for softwood roundwood, there is a chance that different sizes and qualities of trees could be used in mass timber than are currently selected for dimensional lumber. The production of mass timber uses various lengths of lumber by joining them end-to-end and laminating them into large pieces. Mass timber derives its amazing strength by assembling smaller pieces of wood and that might offer flexibility in forest products supply and increase utilization of low value stems for high value mass timber.

As TNC's collaborative project continues, they are seeking additional review and input from third parties such as the Climate Smart Forest Economy Program. With the ability to unite many stake-holder groups and apply their analysis with a global lens, TNC hopes to deliver the best science and analysis of the potential positive and negative impacts of mass timber.

The Forests Dialogue visits the Event Centre Satama in Kotka, Finland, a building under construction with mass timber components in September 2022. Photo by Samuli Skantsi.

Wood Products as Sustainable Materials

October 14, 2021

YUAN YAO, PhD, *Assistant Professor of Industrial Ecology and Sustainable Systems*
YALE SCHOOL OF THE ENVIRONMENT

Yuan Yao

By: Jinali Mody

Yuan Yao, assistant professor of industrial ecology and sustainable systems at the Yale School of the Environment, joined the Yale Forest Forum to discuss her research quantifying the environmental benefit of using wood products and biomass as sustainable materials. Her talk provided answers to some key questions: What are the emissions from wood products vs similar fossil fuel products? To what extent can mass timber lead to carbon storage? What are the environmental impacts of different biomass utilization pathways and are there any trade-offs among different aspects of sustainability?

> ***"Industrial ecology is the study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment, and of the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources."***
>
> – *Robert White 1994 President, U.S. National Academy of Engineering*

Yao began her talk by sharing how the discipline of industrial ecology could be used to accurately measure and compare all the environmental impacts from wood products and corresponding fossil fuel-based alternatives.

Yao also discussed the tools of industrial ecology that are commonly leveraged:

1. **Life Cycle Assessment (LCA):** a standardized tool to quantify and evaluate environmental impacts across all the stages of the product's life cycle. For instance, for wood products it includes impacts across cultivation, production, conversion, usage, and end of life.

2. **Material Flow Analysis (MFA):** an analytical method to quantify flows and stocks of materials and energy in a well-defined system.

3. **Economic Input-Output (EEIO):** a tool used to track the complex economic interactions among different industrial sectors and estimate the environmental impacts associated with different products or services across supply chains.

She then went on to share tangible examples to show how the LCA tool can be used to understand the environmental implications of mass timber.

LIFE CYCLE ASSESSMENT OF CROSS-LAMINATED TIMBER (CLT)

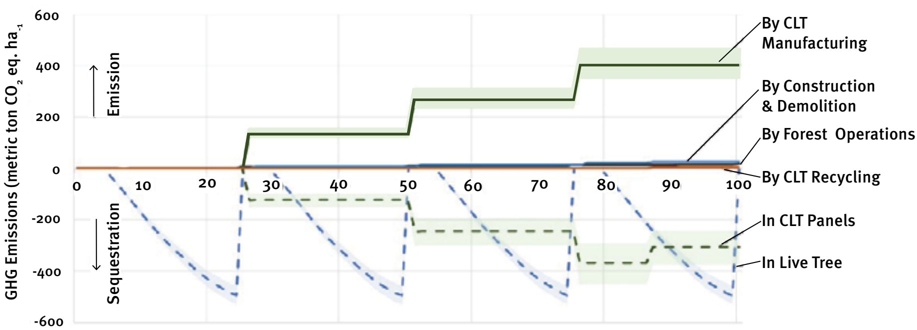
Yao showcased the life cycle of CLT which involves a number of steps under the categories of log production, lumber production, CLT production, CLT usage, and recycling. For instance, log production includes activities like site preparation and planting, use of fertilizers, forest maintenance, and when the trees reach the end of the rotation cycle, harvesting. These activities can be highly dynamic. For example, the speed of forest growth determines the carbon that can be sequestered, and emissions during end-of-life vary depending on whether CLT is being recycled or sent to a landfill. However, it is very challenging to estimate impacts of such a dynamic system given that LCAs are traditionally applied to static conditions. Thus, to address this fundamental and methodological barrier, Yao and her team worked with three dynamic models that served as inputs for the LCA.

Anthony Timberlands Center, University of Arkansas.
Image courtesy of Gray Organschi Architecture/Waugh Thistleton Architects.

1. **To understand the dynamic forest growth** and estimate the number of logs and amount of forest residue generated, a dynamic forest growth model was used to simulate potential scenarios with differentiated productivity and a rotation cycle of 25 years.

2. **Dynamic forest residue decay** was simulated using an exponential model in which biomass would decay to become carbon emitted to the air or deposited in soil. Decay rate data was collected for coarse versus fine wood particles.

3. **Landfill decay rates** and methane emissions estimates from wood residues or CLT at their end of life were estimated using the first order decay model developed by the Intergovernmental Panel on Climate Change (IPCC).



Accumulative GHG flows over 100 years for one hectare of pine forest land with 25-year rotation used for CLT production in the southern United States. Figure by Lan et al. 2020.

These three dynamic models ensure a comprehensive LCA in a defined region, identifying sequestered greenhouse gas (GHG) emissions as shown in the included figure of accumulative GHG flows. The results in the graph can be interpreted such that positive values represent emissions from manufacturing, transportation, lumber production, etc., and negative values represent carbon sequestration. The blue dashed line represents the carbon sequestered in growing trees, the green dashed line represents the carbon maintained in the CLT panels throughout the building's use, and the shaded area shows the uncertainty.

Yao reemphasized that the benefits of CLT include not only carbon sequestered by the standing forest, but also the carbon temporarily stored in CLT, much greater than that which is stored in buildings using cement or steel construction. Apart from the flows illustrated above, additional carbon exists in by-products such as wood and forest residues, which can be sent to landfills or can decay on land, leading to substantial carbon emissions. This demonstrates the strong need to consider the impacts of forest management and the end of life of byproducts in the LCA of wood products.

Based on the dynamic inputs of the LCA, eight different scenarios were studied, the results demonstrating that forests with higher growth productivity led to lower GHG footprints. Recycling of CLT had a small impact on GHG emissions, given that within a 100-year timeframe, most of the CLT would still be in built structures that have not yet reached their end of life. However, if the timeframe were expanded, recycling rates would have a much larger impact.

Yao briefly touched upon findings from other papers:

1. The bulk of CLT emissions are from manufacturing and lumber production, while transportation plays a much smaller role.

2. Downstream usage of sawmill residues to manufacture biobased plastics has a lower environmental and human health impact compared to fossil fuel-derived plastics.

3. The study of cascading usage of lumber from buildings (i.e., the repurposing of the material for another function, or conversion into another product to lengthen the usage period) showed a reduction in the need for additional natural resource extraction and minimization of environmental impact associated with manufacturing with virgin materials. Additionally, since wood products increases the time carbon stays in the economy.

Yao concluded by sharing that while the powerful life cycle assessment tool can help quantify impacts, it is crucial to think about how these results can inform actionable decisions to make a tangible impact.

The Forests Dialogue visits planted forests and conservation forests in Finland to better understand the lifecycle of mass timber. Photo by Samuli Skantsi.

Environmental Impacts of Buildings

October 28, 2021

NIKO HEEREN, PhD, *Adjunct Professor for Industrial Ecology*
NORWEGIAN UNIVERSITY OF SCIENCE & TECHNOLOGY

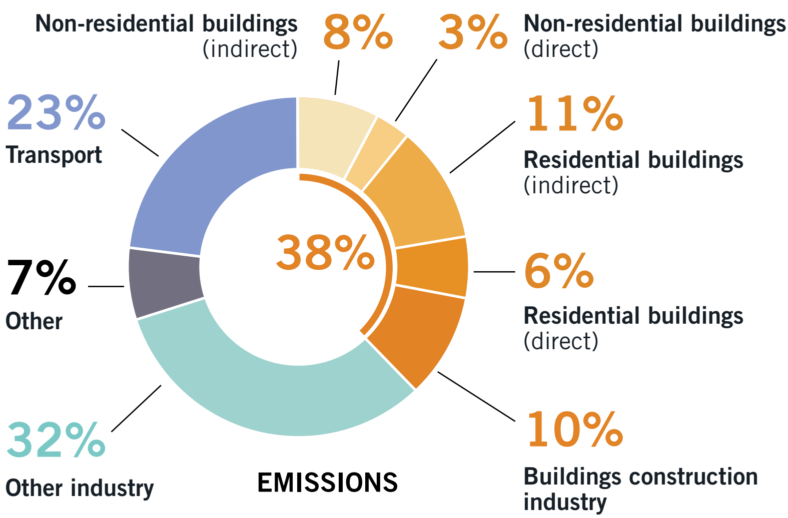
Niko Heeren

By: Levi Shaw-Faber

The building sector is responsible for almost 40% of global greenhouse gas (GHG) emissions, and 10% of global GHG emissions can be specifically tied to the production of building construction materials. Niko Heeren joined the Yale Forest Forum to discuss his recent research that looked at a series of life cycle assessment simulations to get more details on that problem.

The first study compared wood construction to concrete and brick. All buildings are different so they needed to take a very large analysis using 30 different parameters to create a simulation using the Monte Carlo sampling algorithm. The simulation ran a life cycle analysis on 4,500 pairs of buildings using wood vs concrete (including brick walls) over a specific lifespan. The results showed that concrete and masonry buildings had about 3% less energy demand to heat and cool but the wood buildings had about one-third less embodied greenhouse gases in their materials. When combining these two factors, the wood buildings won. Heeren's research suggests that the selection of building materials should be a key consideration when designers want to optimize buildings.

In the second study, the team analyzed the building stock of Switzerland by using 3D and footprint data to get an approximate material volume of every building in the country. They assigned a material composition to the volume and looked at the future of Switzerland, which is trending toward a decrease in population and construction. This will affect the construction industry leading to about the same material inflow into construction as outflow through building demolition. This means that there is less opportunity to substitute wood into the construction industry. Even if they were to substitute a significant proportion of concrete, it would only lead to about a half percent reduction in carbon emissions. Recycling concrete and wood is also not a very impactful solution because both processes require a lot of energy. The one aspect of demolition that would have a significant impact is if the demolished and salvaged wood were used as fuel in district heating plants, leading to a 3.4% decrease in carbon emissions.



According to the UNEP, in 2019, buildings accounted for 38% of global emissions, with residential buildings releasing the greatest proportion of the emission. Figure by the International Energy Agency.

The third study accounted for the global biogenic carbon storage of wood, albeit using a less detailed simulation. The results showed a large reduction in emissions, especially if concrete were substituted for locally sourced wood. Heeren shared that he does believe that wood is a good substitution for concrete because it is less environmentally impactful due to its light weight, lower need for reinforcement, and its lower greenhouse gas intensity. However, the building industry's slow turnover rate decreases its potential use as a short-term mitigator of global GHG emissions.

The Challenges and Opportunities in the Global South

November 4, 2021

MOKENA MAKEKA, *Principal*
DALBERG ADVISORS

Mokena Makeka

By: Emily Goddard

Mokena Makeka, principal at Dalberg Advisors, is an architect, urbanist, and creative whose interests lie in the intersection between design, regenerative development, just ecology, inclusive economies, and the roles of infrastructure and a human centered design strategy. Makeka delivered an inspiring presentation, demonstrating how Gabon can be a leader in building a regenerative forest economy, leading through innovative practices such as mass timber. He began by highlighting the current potential of the built environment to impact climate change, job creation, and ecological renewal, and highlighted the need to understand these issues' interconnectedness with climate. He very purposefully framed his talk around the "forest economy" in the Congo basin, specifically Gabon, citing that there was not national consensus on the importance of "saving" the Congo Forest, but linking economic and ecological regeneration for the purpose of job creation could be more popular.

Per Makeka, regenerative development requires moving away from conventional, extractive economic strategies. Rather, it calls for adopting renewable practices and "systems of life principles" that go beyond sustainability to add value to both natural and human ecosystems. Gabon is a regional leader in this sort of forest protection and sustainable management, being one of the few carbon-positive nations on the planet, and likely the most forested country in the world, with around 88% forest coverage or 180 million hectares of rainforest. Gabon has established laws to ensure that all of its forests are FSC certified by 2022, although currently less than 2.5% of forest land is under sustainable forest management. There have been growing investments into Gabon's forests, specifically around conservation and protection, including financial rewards for forest protection from the Norwegian government.

Known as the “second green lung,” following the Amazon, the Congo Basin is deeply important to global health, supporting food security in Sub-Saharan Africa and impacting other “unseen consequences of unsustainable forest management.” The “Green Gabon” program is one way the country is working to diversify its economy through sustainable beneficiation of its forest resources. Due to the expected doubling of the population of the Congo Basin by 2050, combining rapid urbanization with forest conservation is a challenge, especially considering the vulnerability of the Congo Basin to climate change. Gabon’s environment minister, Dr. Lee White, has championed this work.

Given that 40% of global energy-related greenhouse gas emissions come from the construction sector, sustainable construction of the built environment is a clear path to reduce emissions and

Digital rendering of The Gabon Sovereign Wealth Tower. Image courtesy of Mokena Makeka/Dalberg.

encourage sustainable forest management. The average human spends a large portion of their life inside buildings and the annual global floor area is expected to increase by 2.3% annually. For these reasons, Makeka recommended that we think “tactfully” and combine building technology with urban planning to make cities more efficient while protecting forests. Specifically, he highlighted Zero Carbon construction, which eliminates 100% of embodied and operational emissions and mitigates the negative impacts on the construction sector by building resilient infrastructure and human settlements, promoting inclusive industrialization, and protecting and restoring terrestrial ecosystems (in line with Sustainable Development Goals 9, 11, and 15). As a member of the Green Building Council Board for South Africa, Makeka took a global perspective and demonstrated that countries such as France, Finland, and Japan are “taking the notion of a forest economy and translating it into public policy for the construction sector.”

Makeka highlighted his recent work on The Gabon Sovereign Wealth Tower, Gabon’s first CLT (cross-laminated timber) building, which will be built for the UN on a waterfront marina. The tower concept is based on the honey-comb, which is a very efficient design for air conditioning and also easily replicable. The project targets a zero-carbon rating by maximizing locally sourced wood material. Since Gabon is on the equator, the building is constructed like a brise soleil, allowing natural ventilation and minimal sun exposure through a deep façade with minimal glass. It includes two main buildings totaling roughly 11,500 square meters, floating above an “elevated arboretum” space on the ground floor to allow for public engagement with Gabonese forest species in the space. The depth and layering of

the buildings, as well as the visible timbers, allow for a play of light and shadow.

Makeka additionally highlighted the current technical studies exploring mass timber resources in the tropics. Specifically, he explored opportunities for using locally available softwoods, which are seen as more suitable for this project than hardwoods. Important considerations include the tree growth rates, water absorption, structural strength, and tree trunk diameters.

Makeka and his team calculated the kilograms of carbon that would have been emitted if the project had been a traditional concrete or steel building and compared that to emissions that would be produced with mass timber. They found that the building with mass timber construction would remove 1.5 million kg of carbon. This would have huge benefits in a potential carbon market in which structures themselves either generate revenues of $10-$12 per ton of carbon or are penalized for carbon emissions. Makeka cites this as a "breakthrough moment" for urgent building typologies like affordable housing, which can rely on a 1-3% financial profit margin. It is estimated that the current carbon market will increase in size 100 times by 2050, creating either a carbon bubble or a spike in the value of carbon credits and causing architecture to tip the "financial viability of construction."

Although Makeka has not decided what timber species to use for the project, Gabon has a number of trees with the potential to produce CLT. To decide, the team is looking at market availability, wood density, workability, resistance to insects, deflection over time, how the color of the wood will change over time, as well as the impacts of humidity in Gabon's climate. Keeping consistent with the project's carbon-zero approach, Makeka intends to use eco-cement for the foundation. Makeka and his team are also encouraging the potential for wood to be used for a variety of circular and regenerative business opportunities, from cutlery to paving and furniture. The project plans to plant three new trees for every one tree felled, and two must be planted within 500 kilometers of the felled tree.

The Lake Mjøsa Skyscraper in Brumunddal, Norway, is built of cross-laminated timber. Photo by Øyvind Holmstad.

Makeka and his team also looked at mass timber from a gender and community impact lens, demonstrating how mass timber can enable women and community participation in construction and the value chain, as well as how carbon credits can be translated back to the forests and communities where the wood is sourced.

Makeka closed by asking participants to consider what it means to have a community-based wood economy and how we can participate in carbon trading exchanges and leverage community-based forest stewardship. Finally, he encouraged participants to "celebrate complexity," and explore how we can develop a new way of constructing cities.

Building the Carbon Positive City

November 11, 2021

ALAN ORGANSCHI, *Director*
INNOVATION LAB AT BAUHAUS EARTH

Alan Organschi

By: Jonah Rappaport

Alan Organschi's presentation at the Yale Forest Forum put into perspective the harsh realities of cities and their material compositions today, leading viewers to reconsider the ways in which we build and to envision a much brighter future for cities and the planet as a whole.

Organschi, founder and principal of Gray Organschi Architecture in New Haven, CT, senior critic at the Yale School of Architecture, and director of the Innovation Lab at Bauhaus Earth, Germany, began his presentation with a photo of the steel and concrete megalopolis that is Tokyo, Japan. Recalling the eponymous title of this seminar, "Building the Carbon Positive City," he asked the question: Why is it important to consider the future of wood products in a changing climate?

With an urban population expected to increase by 2.3 billion people by 2050, the global building footprint and land area used are expected to double and triple, respectively. Construction-related emissions are expected to continue to introduce some 26 billion tons of carbon dioxide during this time period, accounting for 40% of total global greenhouse gas emissions. Organschi explained that this trend could actually be reversed if built environment professionals switch to a biological economy using wood products, citing his previous research conducted with a team including this seminar's co-instructor Barbara Reck and Week 3 speaker, Galina Churkina, among others.

Having answered the above question, Organschi continued his presentation with a second question: What is wood?

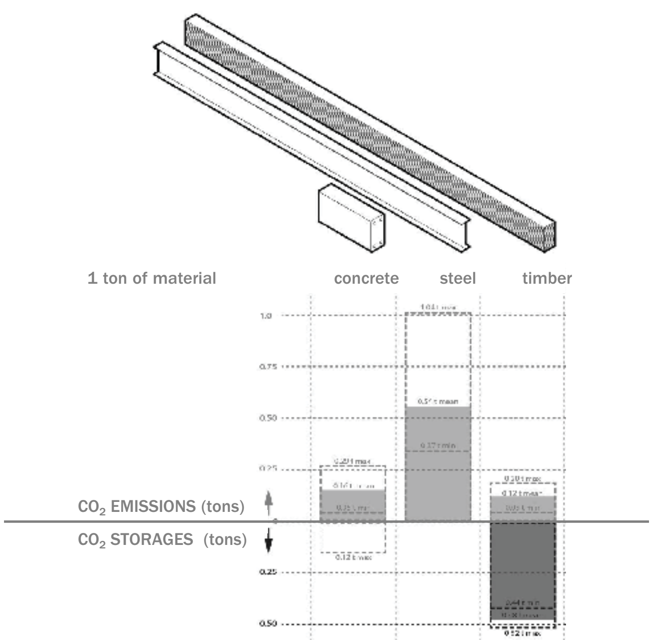
He answered: an economy, a metabolic, domestic, and sometimes catastrophic fuel, a conduit, and a climate stabilizer. A material whose life story can be understood in its knots, checks, and the bifurcations in its cross-section. Organschi remarked that, much like the wrinkles and scars on a human's skin, it is no wonder humans relate to wood in a biophilic way. He explained that in mankind's search for material uniformity and through the

Most modern cities, like Tokyo, are vast, sprawling assemblages of steel and concrete construction. Photo "An urbanized future: Tokyo, greater metro area (2020)" by terence-starkey-Nx77-Apol3E-unsplash.

commercialization of wood, architects and engineers have been able to turn this variable material into all types of products, systems of assembly, and structural typologies which are now internationally recognized as sufficiently reliable to span up to 18 stories with proper encapsulation and even up to 9 stories with fully exposed mass timber.

Organschi noted this recognition has prompted a sort of arms race to build taller and taller with timber, but reinforced his interest in the 5-10 story, mid-rise apartment buildings which will make up the bulk of new buildings that will house the aforementioned 2.3 billion people expected to urbanize in the next 30 years.

Considering 30% of wood in a construction site goes to waste before the building is operational, YFF attendees were asked to ponder his next question: What if wood could be used as a storage bank of reusable building material?



Carbon storage capacity in one ton of concrete vs steel vs timber shows that mineral-based materials have substantial embodied carbon emissions with minimal carbon storage capacities compared to timber. Figure by Churkina et al. 2020.

Organschi demonstrated that while similar in embodied emissions to concrete and steel, wood has an unrivaled capacity to offset its own production stage emissions and serve as a potentially durable carbon sink, noting that a metric ton of timber can store one and a half times its weight in carbon dioxide.

Organschi explained that throughout history, most of our sustainability efforts in construction have been centered on lowering operational emissions and making buildings airtight, highly efficient, and highly insulated. However, by loading all of that material in envelopes and only focusing on this particular part of the building lifecycle, we produce a carbon spike right at the start. He therefore suggested we focus our attention on embodied emissions. Even then, with the climate crisis looming, many question whether lowering embodied emissions is enough, especially considering the sheer number of additional buildings that will be needed to house the billions who will urbanize in the coming decades. This brought us to his next question: If lowering embodied emissions is not enough, how can we reverse them?

Organschi hypothesized that geotechnology, forests working synergistically with massive urban buildings, carefully managed over the course of the forests' and buildings' life cycles, could be the answer to this fundamental problem.

He drew upon his own experience in the industry, explaining how Gray Organschi Architecture has been working with mass timber, testing the material's form and structural capabilities in both remote and urban landscapes for years. He presented several of his firm's standalone projects which make innovative use of mass timber in remote landscapes. These included a grandstand in Staten Island with curved glulam members, a wood-structural framed carousel pavilion in Stamford, CT, with a 40-foot span and an undulating CLT roof, as well as a wood-research center made entirely of wood at the University of Arkansas.

He suggested a possibility for housing in cities with historically unreinforced masonry buildings to be built with light timber

CLT Stair Hall and Core, Common Ground High School.
Photo courtesy of Gray Organschi Architecture/Bensonwood.

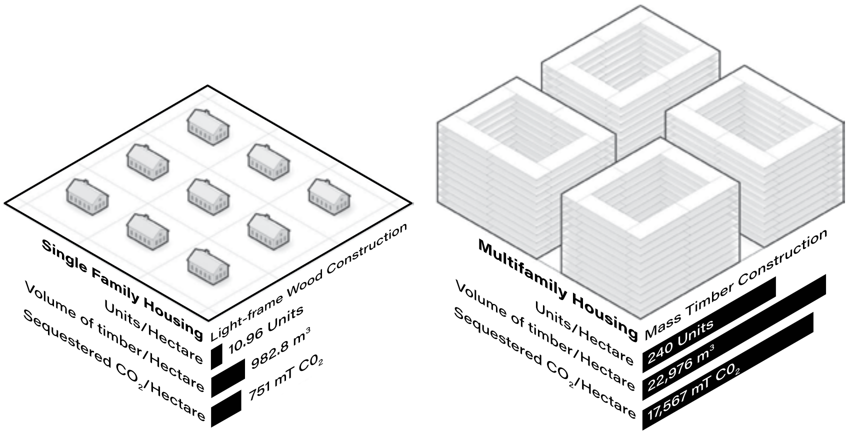
The CLT ceiling of Mill River Carousel Pavilion in Stamford, CT.
Photo courtesy of Gray Organschi Architecture/Structure Fusion.

systems *on top* of existing buildings. Taking the potential for wood housing a step further, Organschi designed an entirely bio-based, large-scale, multi-unit affordable housing project at 340 Dixwell Avenue in New Haven. The 70-unit project, entirely built with CLT, glulam, cellulose fiber insulation, and acetylated wood siding included not only housing and a community center, but also enabled carpentry contractors to learn these new assembly techniques, become certified, and then be able to export their skills to other cities in the northeast.

Organschi then introduced Common Ground High School, an entirely wood building in New Haven that went far beyond simply ticking off “all the sustainable bells and whistles.” Gray Organschi studied all trees and species that went into the building. This included where they came from, their optimum harvest rate, the carbon storage value of the forests in which they were planted, optimal means of moving the wood fiber out of the forest and into the building assembly, and what exactly those carbon impacts and potential storages would be. In addition to this structure being assembled in only 5 weeks with 5 carpenters and a crane operator, the building produced such a significant carbon bank that it would be “net zero” for the first 10 years. The offset carbon from building this 15,000 square foot building is the equivalent of removing 95 cars per year from the road.

Bringing attendees back to the topic of cities, Organschi noted that current models of construction tend to produce suburbia, which is the least efficient housing morphology due to the requirement for extensive infrastructure and transport to service. High intensity/ impact extraction technologies like steel and concrete produce urban morphologies which include high rise and mid-rise buildings that have small footprints and are quite efficient.
In his proposal for the Timber City Research Initiative, Organschi looked at the succession of working forestland in Maine over a 40-year period, dividing it into plots and considering how it might be harvested. Then, he looked at the Ninth Square in New Haven, developing a typology of buildings for this site, including converting parking lots into multi-story engineered wood

Embodied emissions statistics for Common Ground High School.
Figure by Gray Organschi Architecture/Bensonwood.



Comparing the land footprint and carbon footprints of single-family dwellings and multifamily mass timber housing. Figure by Timber City Research Initiative, Gray Organschi Architecture.

buildings. Organschi found that during the time in which New Haven's Ninth Square would be built according to the city's plan, 114,000 metric tons of carbon dioxide would be preserved in the uncut forest and 51,000 tons reabsorbed. In the city, 35,000 metric tons of carbon would be stored by building with wood and 83,000 tons of emissions avoided by not building with cement. In total, this equates to 282,000 fewer metric tons of carbon dioxide in the atmosphere, equivalent to the annual emissions of nearly 64,000 vehicles.

If the environmental impact was not enough of an incentive to consider this proposal, when factoring in the increasing value of damages resulting from emissions-related climate change, this project's carbon bank would be worth many millions of dollars. Together, these statistics should be cause for mass timber construction being a real driver of a restorative and regenerative biological economy in urban settings. Mass timber can indirectly serve as dense carbon storage banks, should professionals of the built environment construct wooden cities with small footprints, carefully managed with the life cycles of forests and buildings. This exciting image of the future city provides a stark contrast to the photo of Tokyo introduced at the start of Alan Organschi's presentation.

Forest Remediation and Communal Life: Restoring the Sumak Kawsay in Ecuadorian Amazonia

November 18, 2021

Ana María Durán Calisto

ANA MARÍA DURÁN CALISTO, *Lecturer*
YALE SCHOOL OF ARCHITECTURE

By: Lydia Jackson

Ana María Durán Calisto, an accomplished architect and current doctoral candidate, joined the Yale Forest Forum to discuss the history, current context, and future of forests and forest products in Indigenous Ecuadorian communities. Despite seemingly sweeping themes, her talk, at its core, was a powerful argument for the critical role of the local. In a webinar series which tended to address international trends, global markets, and forests as broader systems, Durán Calisto challenged the audience to understand how these concepts link back to individual communities. She argued that the future of forests is place- and people-based.

Durán Calisto began by establishing Ecuador's context as a small but important country situated between powerful neighbors within the Amazon region. Overlaying the geographic boundaries of the Amazon and the United States, she suggested that most Americans, lacking immediate experience with tropical forests, have little understanding of this vast area and the scale of its ongoing forest loss. By mapping the extents of mining and oil extraction throughout the region across private and public lands, she exposed how external economic interests directly shape the ecosystem and lives of Amazonian communities.

Durán Calisto then plunged into the core of her critique: that the *chakra* – a traditional way of polyculture farming where layers of cultivated native species nest together within a forest – can provide all that a community could need. Food, medicine, building materials, refuge for animals, and other shared resources. The *chakra* stands in stark contrast to the contemporary extractive landscapes of the region, with monocultures flanking industrial corridors. Durán Calisto then questioned our assumptions and offered alternatives to the business-as-usual practices in the Amazon:

- How can we reimagine forest transit systems to prevent destruction by highways?
- How can we integrate Indigenous knowledge into contemporary agriculture systems?
- Can we restructure power systems on community-based governance models in the Amazon?
- How do we decolonize the extraction of scientific knowledge from the Amazon?
- How can we ensure this knowledge truly benefits the individuals and communities who are the sources of that knowledge?

Durán Calisto's critique culminated in her unpacking of the mismatch between global consumer demand and the local needs of Amazonian communities (despite a climate necessity to protect this critical ecosystem for all humanity). The COVID-19 pandemic exposed the weaknesses of globalized supply chains, along with the risks to human and ecosystem health and of the monocultural agriculture it has inspired. She offered the example of a well-intentioned company working to commercialize *guayasa*, an Indigenous caffeinated herbal beverage, in U.S. markets. Originally supported by Indigenous Ecuadorians as a catalyst for local economic growth, international certifications that accompanied the commercialization of the product instead served to undermine the *chakra* system. The onset of the COVID-19 pandemic froze supply chains, leaving farming families without markets for their *guayasa* crops and therefore neither income nor land to grow food. The constraints of the global supply chain had forced a shift away from polyculture and stranded families during a global crisis.

A boreal forest. Photo courtesy of Gray Organschi Architecture/JIG Design Build.

While the current outlook for forests can create frustration and a sense of hopelessness, Durán Calisto concluded her talk with optimism. While the questions she raises are daunting, she sees some progress, reframing past damage as future opportunities. The network of highways that wrought such destruction, for example, may be an asset: both areas of forest restoration and a way to move Indigenous products to regional and global markets. And she highlighted the hope embodied by Humans for Abundance, an organization focused on this effort to rebuild and reimagine what a more livable and sustainable future could look like – one driven by people and by local communities, not from the top-down by the vested interests of international trade.

Degraded lands along highways in Amazonia could be reframed as opportunities to work with highly organized communities and invest in restoration through productive polycultures. Photo courtesy of Ana María Durán Calisto.

XL to XS: Mass Timber Architecture Across Size and Typology

December 2, 2021

TOM CHUNG, *Principal*
LEERS WEINZAPFEL ASSOCIATES

Tom Chung

By: Lauryn Sherman

Tom Chung, principal at Leers Weinzapfel Associates, shared his experiences designing and building healthy, mass timber-constructed spaces with the Yale Forest Forum. The lecture connected themes of environmental sustainability, constructing buildings with mass timber-engineered woods, and the human experience of well-being within these sustainably- built environments. The projects he shared ranged in scale from very large to very small.

First, he described the design for Adohi Hall at the University of Arkansas, a 200,000 square foot housing building that won the AIA Housing Award in 2021. The building was a publicly-financed dormitory that needed to maximize the number of student rooms to make the project economically viable. Ultimately, the firm achieved a relaxed-feeling building inspired by the regional Ozark forests with enough housing for 700 students. The firm met the technical challenge of accommodating a limited supply of large mass timber materials through a simple structural grid using CLT panels and glulam beams and columns. On the ground floor, the team used a V-shaped queen-post truss to span a large student gathering space. The finished building features housing at the upper levels and communal program at the ground level, emphasizing a flow between indoor and outdoor spaces.

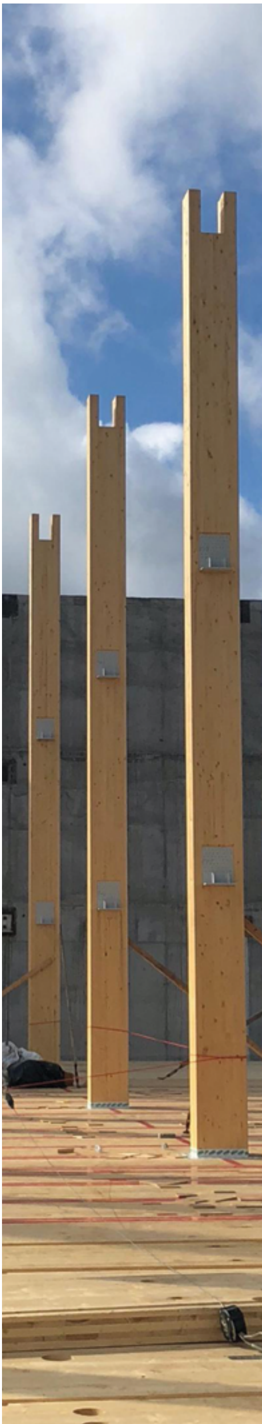
John W. Olver Design Building at the University of Massachusetts, Amherst.
Photo courtesy of Albert Vecerka/Esto.

Chung then presented the John Olver Design Building at the University of Massachusetts, Amherst. The project is a demonstration site for sustainable design that brought together three different departments at the University. The 87,000 square foot building is the first and largest CLT building in the U.S., featuring a courtyard-like central space (a two-story commons) and a rooftop garden. The building design utilized post-and-beam elements that wrap around the central courtyard. The architectural team sought to connect the garden and interior space by creating a large, skylit column-free staircase. A custom “zipper” truss showcases an efficient and complementary balance in the use of steel and wood.

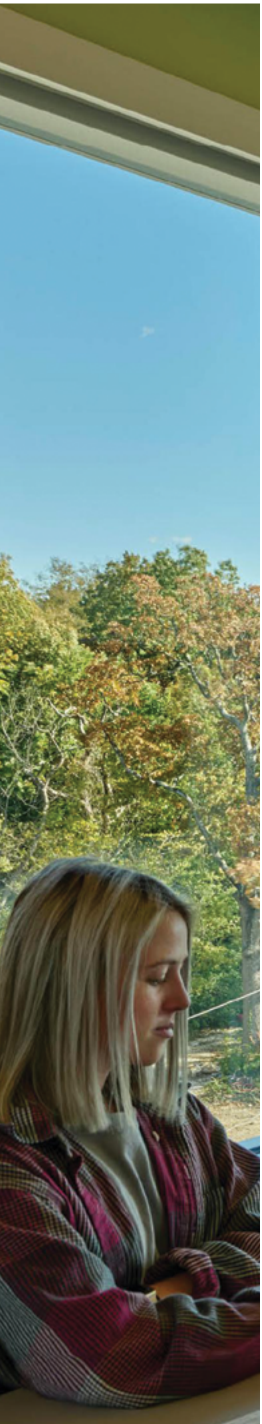
For his third project, Chung shared an exciting design for the Conservation Legacy Center in Missoula, Montana. The building celebrates the nation's forests at the National Museum of Forest Service History and features wood from many of the significant tree species from the nation's forests. The wooden ceiling design element is a geometric interpretation of a tree-like canopy.

The last building concept represented was also the smallest: a nature-based preschool at Auburn University. The goal of the design was to utilize wood for its entire structural assembly. The building is nestled within the forest from which the wood that comprises it was harvested.

Concluding the Speaker Series, Chung left the audience with a sense of possibility. His presentation created a window looking into the future where the built environment is composed of more mass timber buildings than today, sourced, designed, and built in a way that supports improved forest management, community development, and decarbonization efforts.



Vertical wooden columns in Adohi Hall, University of Arkansas.
Photo courtesy of Tom Chung/Leers Weinzapfel Associates



Conclusion

By: Luca Guadagno

The Yale Forest Forum's Speaker Series, "The Future of Wood Building Products in a Changing Climate," brought together speakers to explore the potential role wood products can play in decarbonizing the building sector, incentivizing improved forest management, and addressing a range of resource, societal, and environmental challenges. Speakers highlighted a number of potential benefits associated with using mass timber sourced from sustainability managed forests. A number of challenges and outstanding questions were also highlighted including policy and social license gaps, uncertainty around using species for timber outside the handful of softwood plantation species currently being utilized, and limited opportunities to analyze end of life scenarios for mass timber products. As these questions and challenges are addressed, knowledge-sharing platforms like YFF will be crucial to overcoming challenges and ensuring actors across the value chain can move forward with the best available information. There is no one-size-fits-all solution and instead, delivering the potential benefits of wood products like mass timber while avoiding negative consequences will be an ever-evolving process of weighing the complex tradeoffs at play.

Study hall at Adohi Hall, University of Arkansas. Photo courtesy of Tom Chung/ Leers Weinzapfel Associates.

Back cover: Mass timber footbridge. Photo courtesy of Gray Organschi Architecture/UNALAM/JIG Design Build.

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