YALE FOREST FORUM SPEAKER SERIES SUMMARY



September – December, 2022 New Haven, Connecticut, USA FALL 2022

(Re)Considering Planted Forests for the 21st Century



YFFReview

The Forest School at the Yale School of the Environment

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Front cover photo: A planted radiata pine forest in New Zealand with established trees in the mid-ground and recently planted trees in the foreground. Photo courtesy of TFD.

Left photo: Planted forests in a mountainous landscape in Chile. Photo courtesy of TFD.



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.





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Introduction

By: Ryan Smith

The Yale Forest Forum convened a free weekly public webinar series on "(Re)Considering Planted Forests for the 21st Century," jointly hosted by The Forest School at the Yale School of the Environment (YSE) and The Forests Dialogue (TFD) in fall 2022. The series focused on large-scale planted forests for fiber and wood products in the context of climate change, innovation, and meeting society's various needs. A wide range of experts were featured, representing viewpoints from academia, conservation nonprofits, the forest products industry, and Indigenous and forest-based communities. Speakers discussed the future role of planted forests at regional and global scales, and they explored the tensions between social and environmental challenges and the equitable distribution of planted forests' benefits. This review is a compilation of summaries of the presentations in this speaker series, written by graduate students in a Yale seminar.

Peter Kanowski (Australian National University) set the stage, demonstrating that planted forests can take many forms, depending on local to global conditions, values, markets, and desired products. Forests are planted for community ownership, landscape restoration, and the provisioning of wood, nontimber forest products, and environmental services. Increasingly, forests are also planted for their potential to sequester carbon and mitigate climate change. Planted forests are unparalleled in their potential to yield high volumes of wood fibers on a per unit of land area basis, and they can deliver environmental services and social benefits, too. However, they remain controversial, with concerns over potential environmental and social costs outweighing their benefits.



Planted forests surround a recreational site in New Zealand. Photo courtesy of TFD.

(Re)Considering Planted Forests for the 21st Century

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Much of the concern around planted forests is related to their potential impacts on smallholders. As speakers Marcus Colchester (Forest Peoples Program), Rod Taylor (World Resources Institute), and Peter Kanowski pointed out in this series, plantation forestry has been associated with land grabbing, the concentration of land ownership, the dislocation of people, and even gender violence. Negative environmental impacts can include increased risks of fire, pests, erosion, and water pollution. Biodiversity can also be negatively affected when native vegetation is replaced by nonnative tree plantations. Minnie Degawan (Conservation International) noted that Indigenous peoples are often excluded from the process of deciding when, where, and how forests are planted. Communities often do not understand why trees are being planted and the forests do not support their value system. As a result, the plantations can fail to deliver benefits to local communities.

Despite these challenges, planted forests continue to grow in both extent and significance. Several speakers noted that tree plantations provide almost half of the world's commercial wood supply, a proportion expected to significantly increase in coming decades. Yet planted forests still represent only a fraction of the world's tree cover. Rod Taylor pointed out that in the present day, the increases in planted forest area are largely occurring on land that was once forested and was cleared of native vegetation long ago, not land that is being cleared for conversion into a planted forest. **Ara Erickson** (Weyerhaeuser) urged the audience to see forest plantations as part a larger system in the landscape. At any given point in time, the majority of Weyerhaeuser's land is maintained as a growing forest that continues to provide many of the ecosystem services that would be provided by a naturally occurring forest.

Looking to the future, speakers addressed how historic challenges of plantation forestry can be overcome and how planted forests can more effectively meet society's needs. **Andrew Heald** of New Generations Plantations (NGP), which was founded by WWF,

A recently planted intensively managed forest in Indonesia. Photo courtesy of TFD.

described how his organization connects local stakeholders with forestry companies and external investors to scale and sustain forest restoration initiatives. **Luis Neves Silva** (WWF) elaborated on NGP's "landscape approach," which brings stakeholders together to collaboratively engage in landscape planning with the goal of ensuring that plantations can simultaneously be profitable, serve important ecological functions, and provide employment, economic development, and other social benefits. **Mark Wishnie** (BTG Pactual Timberland Investment Group) discussed how frameworks, such as Brazil's forest law and carbon markets, can help scale the benefits provided by plantations. Colchester spoke about how the Forest Stewardship Council (FSC) is developing a process for remedying past wrongs done to Indigenous peoples by forest plantations.

Innovation within the forest sector is already playing a key role in adapting plantation forestry to modern needs. Silvicultural advancements, discussed by **Francisco Razzolini** (Klabin), are increasing productivity in planted forests, thereby reducing the area of land that must be planted to keep up with the growing demand for wood products. Emerging chemical technologies are also expanding the potential applications of wood. According to **Yuan Yao** (Yale School of the Environment), integrating diverse wood products into a circular economy can displace the use of less sustainable materials.

This speaker series provides an overview of challenges, opportunities, and tradeoffs associated with the establishment of planted forests. By understanding the issues, thoughtfully integrated tree plantations may meet many of society's modern and future needs moving forward.

This seminar is the third YFF series focused on the "Future Role of Forest Products in a Changing Climate." The first in the series covered issues related to mass timber, the second on bioenergy. All materials referenced in this document including, bios for speakers, readings, and all webinar recording material, can be found on the Yale Forest Forum website.







Global Overview of Planted Forests

Presented: September 6, 2022



Peter Kanowski

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PETER KANOWSKI, PhD, Professor of Forestry AUSTRALIAN NATIONAL UNIVERSITY

Summary by: Zane Weinberger

For the first Yale Forest Forum talk of the series, Peter Kanowski gave a global overview of planted forests, their current role in restoration, climate change mitigation, wood production, and how their presence and management affects lives and livelihoods. Peter Kanowski is a professor of forestry at the Fenner School of the Environment and Society in the Australian National University in Caberra. He has also worked with The Forests Dialogue on the "Intensively-Managed Planted Forests" and the "Tree Plantations in the Landscape" initiatives.

Kanowski began his presentation with contrasting case studies, exemplifying how planted forests can differ in character and purpose, globally. He compared a landscape in southwest Germany with that of the Great Green Wall Initiative in Sub-Saharan Africa. The planted forests in Germany exist as a matrix, inter-woven with agriculture and urban uses, while the Great Green Wall Initiative's goal is to plant 8,000 km of trees to help restore degraded landscapes and provide job and food security. These two examples of actively managed, planted forests are unique in their management objectives, land ownership, and purposes.



Planted forests can take many forms, from this pine plantation in Portugal (left) to teak agroforestry systems in Java, Indonesia. Photos by Peter Kanowski and Tony Barlett.

Kanowski then introduced the idea of a continuum of characteristics shared by all forests – planted or naturally regenerated. The continuum starts with forests in which management does not modify structure on one end, moves toward planted forests with varying degrees of structure and management in the middle, and then includes trees outside of forests, such as those planted in urban settings, on the other end. It is also helpful to remember that forests can have multiple uses along a continuum, ranging from less intensive to more intensive.

Kanowski addressed reasons why a forest might be planted in the first place and how forests with similar uses can differ in form. The purposes for planting forests might include community ownership, landscape restoration, the production of wood products, and/or carbon projects. To highlight these contrasts, Kanowski examined how a "plantation" could refer to a single landowner or a group of farmers planting a relatively small area of teak in Java or a massive eucalyptus crop being harvested for pulp and paper export in Brazil. Similarly, landscape restoration projects can be community-based initiatives or global tree-planting challenges.

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Moving on from the purposes and forms that planted forests can take, Kanowski discussed global trends in the scale and productivity of industrial forest plantations. He emphasized that area covered by natural forests is decreasing and the total area of planted forests is increasing both in absolute area and as a proportion of all forests. As a result of this change, consumers are increasingly getting their wood and wood-products from planted forests. According to Kanowski, planted forests make up only 7% of all forests, but produce 50% of roundwood harvested globally.

Kanowski then introduced some of the controversy surrounding planted forests. Often, the social and economic impacts of forest plantations on small-holders and communities are not considered. Much of the criticism surrounds large scale operations and extremely short crop rotations. As part of this discussion, critics often argue that plantation forests are not forests at all, given that they are monoculture production systems and cannot provide the same range of ecological values as natural forests.

Naturally regenerating forest Plantation forest

Naturally regenerating versus planted forests, 2020 (% of global forest area)

Planted Forests represent approximately 7% of forests worldwide yet provide approximately 50% of the global roundwood supply. Figure by FAO, 2020. Wood trade data from Payn et al., 2015.

To summarize this vast topic, Kanowski listed several realties that are inescapable in the discussion and use of planted forests:

- 1. Negative effects and environmental damage done by poor land use decisions are part of the legacy of planted forests. This includes effects on ecosystems, such as the weakening of forests' resiliency to stressors like fire and pests, and effects on peoples, such as historic land grabbing, dislocation, and dispossession of communities.
- 2. Plantations are a highly productive land use that can provide a matrix of values and contribute to the conservation of natural forests. Through understanding these realities and incorporating industry goals and expectations, forest plantations can satisfy the needs of the industry, ecosystem, and people.
- 3. Opportunities and challenges exist as planted forests continue to account for a greater proportion of the global forested area. Examples of significant opportunities include the potential for planted forests to take on larger roles in the move toward a global bio-based economy and in mitigating climate change.

Looking to the future, Kanowski left the audience with a few questions. Given that planted forests, in all of their forms, will become a more significant presence, how do we ensure that all affected parties are benefitting socially and economically? Principles from organizations like New Generation Plantations and the ideas that will be discussed in this series can help to guide us and our use of planted forests into the future. These principles include good governance, corporate responsibility, equitable sharing of benefits and costs, a total-landscape level approach, and accounting for sustainability across scale and time. However, the most significant challenge will be in the implementation of these principles. The demand for forest products is not going anywhere and finding a way to responsibly expand planted forests is, and will continue to be, paramount.



A commercial eucalyptus plantation in Bahia, Brazil. Photo by Thomas Harris.





The Role of Industrial Plantations in Producing Wood Products in Today's Global Bioeconomy

Presented: September 13, 2022

ANDREW HEALD, Director NEW GENERATION PLANTATIONS TECHNICAL ASSISTANCE



Andrew Heald, co-founder and director of New Generation Plantations Technical Assistance (NGPTA), joined the Yale Forest Forum to discuss the role of industrial plantations in producing wood products to meet the needs of today's global economy. He explored the social, environmental, and economic challenges of expanding forestry plantations. With over 25 years of experience in sustainable forestry and plantation management, he currently facilitates large-scale forest landscape restoration projects for NGPTA in Ghana, Brazil, Mozambigue, and Chile. Heald brought an on-the-ground perspective and a wealth of expertise to the second session of the series. His talk built off the series introduction to the "how" and "why" of planted forests, broadening the discussion to consider the "what," "when," and "who" and to help answer the question of "how can we best ensure that plantations are integrated with other land uses and create value for local communities?"

Throughout his presentation, Heald shed light on the challenges that remain in implementing the next generation of planted forests and encouraged the audience to think critically about how to evaluate the tradeoffs that underlie all decision making in the sector. He began by discussing tradeoffs and the history of government incentives to support plantation development. He raised the challenge of the long-term nature of the forest products industry and emphasized that decisions about forest management and species choice are often influenced by dynamic events that are



Andrew Heald

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completely outside the control and purview of local forest owners and regional governments. The markets for timber products that exist when a landowner makes the choice to transition (or maintain) their land as forest will likely have changed due to local and global forces by the time the trees are cut. Industrial plantations play a practical role in our economy today, yet regional and national land use planning and governance are critical to ensuring that we are producing these materials in a way that both minimizes their impact on the land and respects and benefits the communities in which they are located.



The bioeconomy of planted forests must consider tradeoffs between who is involved and where, when, and how they are implemented. Figure courtesy of Andrew Heard.

Next, Heald shifted to introduce the NGPTA's work. The organization was established in early 2020 to help support the development of large-scale, resilient landscape restoration projects that incorporated natural forest restoration, agroforestry, and commercial forestry as a part of their implementation. While NGPTA's main focus is on natural forest restoration and community empowerment, they often partner with commercial forestry operations and plantation companies working in the region. Altogether, NGPTA seeks to connect local communities and farmers

with forestry companies and external investors to get natural forest restoration projects off the ground and sustain their operation into the future. NGPTA builds off of the methodology and principles piloted by New Generation Plantations 12 years ago:

- Maintain ecosystem integrity
- · Protect and enhance high conservation values
- Develop thorough effective stakeholder involvement
- Contribute to economic growth and employment



NGPTA's forest landscape restoration initiatives involve key elements providing economic development, conservation, and food security to communities. Note: Commercial-Community bridge and Community to Commercial evolution are not displayed on the map. Figure courtesy of Andrew Heald.

To date, NGPTA has implemented this model with two projects in Brazil and Ghana, and they are actively working on four additional projects. Today, they are demonstrating that is it possible to restore biodiversity and ecosystems along with commercial timber production and social and economic development.

NGPTA Portfolio

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Commercial Forestry and Forest Products

Presented: September 20, 2022

ARA ERICKSON, Vice-President, Corporate Sustainability WEYERHAEUSER

Summary by: Shaylyn Austin and Joshua Friedlein

Ara Erickson, vice president for corporate sustainability at Weyerhaeuser Company, spoke to the Yale Forest Forum's Seminar on Planted Forests about the role of industrial-scale planted forests in commercial forestry and forest products. Throughout her talk, Erickson encouraged attendees to consider landscapes as systems and to remember the key roles that planted forests play in global supply chains.

Erickson began by telling her personal story and connection to commercial forestry. Her parents, who were environmental activists in California, encouraged her to consider the impact that people have on the world. While in college, she discovered that she could explore the relationality of humans to natural resources through forestry and fell in love with the complexity of decisions that need to be made around forests.

Presenting a photograph of a coniferous forest in the United States Pacific Northwest, Erickson asked attendees to write down things that they notice in the photograph. After asking attendees to close





Ara Erickson

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their eyes and then look at the photograph again for new insights. Erickson pointed out the complexity of the landscape displayed and stressed the importance of thinking about that landscape as a system in working landscapes.



Tree planters in the Western U.S. Photo courtesy of Ara Erickson / Weyerhaeuser.

Erickson then spoke about the various perspectives with which people view working forests. She described a binary of perspectives between what industry "knows," which she claimed is based on "experience & science," and what society "knows," which she claimed is based on "emotion and belief." For Erickson, the middle ground between emotion and experience is the place at which both of these groups that love forests can have productive conversations about the use of planted forests in the commercial forestry context.

The crux of Erickson's talk came when she made the distinction between systems and parts in working forests. After presenting data on the breadth of Weyerhaeuser's timberland holdings in the states of Oregon and Washington — ranging from recently harvested stands to planted lands, mature stands of 90+ years, and protected areas — Erickson acknowledged that the photographs of recently harvested landscapes often dominate conversations of commercial forestry. However, she emphasized those areas are only a small portion of the entire system of Weyerhaeuser's 2.5 million acres in Oregon and Washington.

Erickson then outlined the process by which Weyerhaeuser manages its planted forests. Beginning as seedlings in nurseries, trees are planted and cared for by hand to ensure survival. After a period of time, the planted forests reach maturity and are harvested, loaded up, and taken to a mill for processing and distribution to markets. Erickson stated that Weyerhaeuser seeks to produce most of its commercial wood volume as saw timber, while pulpwood and fuelwood are created from trees harvested in thinnings or other silvicultural treatments.

Erickson presented how Weyerhaeuser captures superior value at every step of the supply chain. Weyerhaeuser's proprietary seedlings grow faster and yield the highest quality wood products. She emphasized that Weyerhaeuser knows how to get the maximum amount of material out of the timber that comes into mills through highly efficient processing. The Weyerhaeuser process is underpinned by income from land sales, natural climate solutions, land royalties, and leases. She also emphasized that Weyerhaeuser only harvests about two percent of their lands each year.

Erickson then discussed market dynamics for Weyerhaeuser's products. Their business supports new residential, residential repair, and nonresidential construction. Four industry drivers were noted: 1) U.S. housing starts, 2) construction of wood-based buildings, 3) global demand for wood fiber, and 4) demand for natural climate solutions. Weyerhauser must not only sell their products today but also anticipate demand for wood products 40–50 years in the future and maintain a diversity of age classes and species compositions to meet those future market conditions.

In closing, Erickson encouraged attendees of the Yale Forest Forum to not think of planted forests as one acre today, but what a couple million acres might look like in five decades. According to Erickson, we must focus on the overlapping area of human needs and the needs of earth's natural systems, and not just think of forests as a single solution, but many solutions. While not all forests provide all the benefits we may want, all forests can provide some of the benefits we seek.







Sustainable Management and the Landscape Approach

Presented: September 27, 2022



LUIS NEVES SILVA, New Generations Plantations Lead WWF

Summary by: Raqib Valli and Alex Healey

Luis Neves Silva, platform lead for WWF's New Generation Plantations (NGP) initiative, joined the YFF series to discuss NGP's efforts to promote a landscape approach to planted forest development and stewardship.

Luis Neves Silva

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In his opening remarks, Neves stated that "planted forests always come alongside contention," acknowledging the sector's fraught history of corporate land grabs, cultural disagreements over land use, and destruction of native habitat. In response to the challenges facing the global forestry industry, stakeholders from the private sector, civil society, and government came together in 1993 to form the Forest Stewardship Council (FSC). According to Neves, FSC's holistic consideration of social, environmental, and economic factors represented a significant step forward in encouraging more sustainable forestry practices and improved land stewardship.

However, Neves said, in the years following the FSC's launch it quickly became clear that there was still an urgent need for a dedicated forum where stakeholders could workshop solutions to plantation forestry's most intractable challenges. Building on initial discussions hosted by The Forests Dialogue, the New Generation Plantations initiative was founded with support from WWF to fill this gap.

A central component of NGP's model is the utilization of a "landscape approach" to consider the role of plantation forestry in a given region. Through this more inclusive and collaborative method of land use planning, Neves shared that NGP's ambition is to prove that it is possible to reconcile conservation and biodiversity protection with efficient and profitable forestry. In practice, this means that NGP and its local partners strive to engage a broad array of stakeholders in a structured dialogue that is designed to ensure that weight is given to each of NGP's principles for landscape-based planted forest development and stewardship. These principles include maintenance of ecosystem integrity, protection of high conservation value areas, development of solutions via stakeholder engagement, and contribution to local economic growth and employment.

A central tenet of the landscape approach, Neves elaborated, is that each individual landscape has the potential to host multiple business models that enable a suite of co-benefits. These benefits can and should range well beyond standard metrics of economic production. While these are essential, NGP's approach emphasizes carefully considering how the ecosystems within a given landscape can provide a much more diverse set of service values, ranging from water quality maintenance to cultural significance.

In practice, this process of co-creation alongside stakeholders often first results in what Neves calls "theoretical landscape models," wherein a variety of possible land uses are interwoven. Once a model is established, project development and fundraising can follow. The Figure below depicts how a theoretical landscape model might divide a region into various bankable projects that are tailored to appeal to specific stakeholders or investors.



Landscape-level planning can include the restoration of native species, as well as home-scale and commercial forestry and agriculture, financed using a combination of impact investing, loans, and equity. Figure courtesy of Luis Neve Silva.

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Despite its clear socio-ecological benefits, NGP's landscape approach has yet to achieve scaled adoption. Why? Neves believes that the answer lies in the fundamental mismatch between this model and the capital that is currently available to support plantation forestry projects. On one hand, he said, traditional investment approaches offer financial scale and a long-term time horizon while providing little incentive for developers to consider social and environmental externalities. On the other hand, more philanthropically-oriented funding that does consider externalities is often too small-scale and short-term to achieve success via a landscape approach.

To answer the question of how the funding gap might be bridged, Neves argued, "this can only be implemented through complex collaborations." The territory-level interactions that NGP seeks to facilitate must be specific to the landscape and bespoke to the interests of each stakeholder group. Through this process of engagement, Neves believes that it is possible to identify shared values around which an investment case can be constructed.

After detailing the complexity of implementing planted forests using a landscape approach, Neves closed on a more hopeful note, offering two brief case studies of New Generation Plantations' work in central Ghana and northeastern Brazil. Although both are still in-progress, each offers evidence that a landscape approach is certainly possible to achieve when developed in thoughtful collaboration with the right partners.



New Generations Plantations' landscape approach involves identifying shared values to make landscapes attractive for investors to reconcile social and environmental benefits with profitable forestry. Figure courtesy of Luis Neves Silva.

WATCH SESSION

VIDEO

Planted Forests and Circular Economy

Presented: October 4, 2022

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

Summary by: Lachlan Byrnes and Thoko Changufu



Yuan Yao

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Yuan Yao, assistant professor of industrial ecology and sustainable systems at the Yale School of the Environment, started her talk by contrasting a "linear economy" with a "circular economy." In a linear economy, raw natural materials such as timber are produced and then travel through the stages of production and use, ultimately ending as waste. In contrast, a circular economy endeavors to "close the loop" and recirculate that waste as usable material.

Planted forests and naturally regenerated vegetation on the banks of a lake in New Zealand. Photo courtesy of TFD.

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Yao used a butterfly diagram to further elaborate on the concept of a circular economy. On the left side of the diagram are biological strategies for recirculating materials in nature, such as converting would-be waste into fuels and fertilizers. On the right side, technical strategies, such as sharing, refurbishing, and re-manufacturing, aim to continuously use materials, preventing them from ending as waste.



The butterfly diagram shows biological (left) and technical (right) strategies in a circular economy. Figure from the Ellen MacArthur Foundation, 2019. Yao then explained the 9 R's, or principles of circular economies. These can be broken down into three categories, many of which are included in the butterfly diagram:

CATEGORY 1: SMARTER PRODUCT USE AND MANUFACTURING

- **Refuse:** Make a product unnecessary by abandoning its function or by offering the same function with a radically different product.
- Rethink: Make a product able to be used more intensively.
- **Reduce:** Minimize natural resource consumption in a product's manufacturing or use.

CATEGORY 2: EXTEND THE LIFETIME OF PRODUCTS/PARTS

- Reuse: Continue use of a product by a secondary consumer.
- Repair: Maintain a product so it can continually be used.
- **Refurbish:** Restore an old product so it does not become obsolete.
- **Remanufacture:** Use parts of a discarded product to make a new product with the same function.

CATEGORY 3: FULLY USE MATERIALS

- **Repurpose:** Use an old product or its parts in a new product with a different function.
- **Recycle:** Process materials to create another product with an equal or lesser quality.
- **Recover:** Generate energy by incinerating the product.

Following this, Yao transitioned into discussing the potential use of forest residues. Defined as branches, foliage, and small diameter trees that are generally leftover from timber harvests, forest residues can pose a risk as they accumulate in forests and exacerbate wildfire risk. Yao highlighted the general availability of

A smallholder pine plantation for local markets in Chile. Photo courtesy of TFD.



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forest residues in the western and northeastern U.S. and presented a case study of how forest residues can be valorized using circular economy principles. The case study explored how much energy can be produced from forest residues. The study demonstrates that the conversion of residues into various forms of energy (e.g., electricity, biofuels) has a smaller carbon footprint when compared to burning forest residues. Yao also shared findings from a paper she published in *Nature Sustainability*, which show the life cycle assessment for a bio-based plastic as an example of utilizing forest residues.



Life-cycle results of processing 1 ODMT of three types of urban tree waste

The relative impacts of different pathways for urban forest residues on carbon emissions. Figure adapted from Lan et al., 2022.

Continuing in this vein, she questioned how circularity gels with sustainability. Yao described the three pillars of sustainability, including environmental, economic, and social aspects. She further described life cycle assessments as a means of assessing the environmental impacts of products over their lifetimes. She used the example of wood products to illustrate how this can help us think about the sustainability of different strategies. She cited a paper she recently published, identifying that urban tree waste can be turned into lumber, compost, mulch, and biochar as alternatives to dumping in landfills. These pathways all come with their own benefits, too. For example, compost reduces fertilizer use and biochar can replace charcoal made from fossil fuels. The results of the paper show that all these pathways are better than the tree waste ending its life cycle in the landfill. However, different regions have different urban tree wastes and are therefore amenable to different use pathways.



Planted forests provide timber and raw materials for many other products in a circular economy. Figure by Metsa Group.

Yao tied these ideas back to planted forests by considering how planted forests themselves provide ecosystem services which are important to the circular bioeconomy and need to be factored into the sustainability assessment. In addition, she insisted that we have to be careful of the risk of overusing materials that involve new sustainable practices to the point where the benefits are canceled out. For example, the benefits of using forest residues should not encourage excessive timber harvest.

Yao finished her presentation by discussing how complicated the circular bioeconomy can be and highlighted that integration across supply chains is important in sustainable systems.



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Environmental Challenges and Planted Forests

Presented: October 11, 2022

ROD TAYLOR, *Global Forests Director* WORLD RESOURCES INSTITUTE

Summary by: Molly Charles

Rod Taylor, global director of the forests program at the World Resources Institute, gave a presentation outlining the arguments against planted forests. Taylor focused on two areas of criticisms – against planted forests in general and against tree planting as a climate solution. After presenting both the arguments and counterarguments, Taylor shared tools and approaches to address concerns around planted forests and to improve their outcomes for both people and the environment.

Taylor began the presentation by showing an image of a landscape containing patches of natural forest alongside plots of eucalyptus plantations. Pictures like these evoke strong reactions, either negative or positive, depending on the viewer's preconceptions of planted forests. Taylor's intent was not to state his own opinions on planted forests or those of WRI, but rather to provide a survey of critiques and counterviews, challenging the audience to recognize the differing lenses through which people view this issue. Taylor then showed the Global Forest Watch's maps of where planted forests and agricultural tree crops are distributed throughout the globe as well as the species most frequently planted.

Radiata pine plantation in New Zealand with slash in the foreground, left behind after a harvest. Photo courtesy of TFD.



Rod Taylor

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A common term for such areas, used by the FAO and other organizations, is "plantation forest." However, whether planted forests can be considered forests at all is a fundamental debate. Similarly, there is controversy over whether planted forests can qualify as restoration or reforestation. Taylor explained that this is a complicated question because there are different types of restoration — such as natural regeneration and active restoration — with different benefits ranging from biodiversity protection to carbon sequestration, cost, economic potential, and others. In general, there are tradeoffs between economic benefits and biodiversity benefits.



Near-global map of planted forests and agricultural tree crops

Global Forest Watch's worldwide map of planted forests and agricultural tree crops. Figure courtesy of Rod Taylor / Global Forest Watch / WRI.

Taylor then outlined the major critiques of planted forests. When companies replace native ecosystems or agricultural lands with industrial forest plantations, they can be criticized for promoting deforestation, the loss of fertile soil and biodiversity, and depleted or contaminated water resources. Criticisms also focus on the impacts that plantation forests have on local communities, often creating fewer jobs than promised. Jobs that are created can be low-paying and dangerous. Security around plantations, often an outcome of insecure land tenure, restricts freedom of movement for the community and can subject them to harassment and YFFReview

surveillance. For women in particular, establishing planted forests can impact their capacity to produce food and increases the prevalence of harassment and sexual violence.

How Do Different Restoration Techniques Bring Value To People And Planet?

	Туре	Cost	Biodiversity Benefits	Economic Potential
Natural regeneration	Natural forest regrowth		<u>,,,,,</u>	↑ ↑↑↑↑↑
	Assisted natural regeneration		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	↑ ↑↑↑↑↑
Active restoration	Ecological restoration		,,,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	↑ ↑↑↑↑↑
	Small farmer reforestation, e.g. agroforestry, woodlots		ØØ ØØ	↑ ↑↑↑↑↑
	Commercial, large-scale reforestation		,	↑ ↑ ↑ ↑ ↑
	Commercial reforestation with safeguards, e.g. certification	<u> </u>	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	↑↑↑↑↑

Different restoration techniques have different costs and potential economic and biodiversity benefits. Figure courtesy of WRI, adapted from Chazdon et al., 2017.

There are counterviews to these critiques, which Taylor then summarized. A tradeoff exists between producing industrial wood from natural forests and plantations or from plantations. Many argue that planted forests can take pressure off of natural forests as a wood source, as long as plantations are not leading to deforestation. It would therefore be preferable to intensify production of forest products on plantations, rather than increasing harvests from natural forests. Deforestation caused by plantation expansion does occur in some regions, but generally this has lessened over time. The impact of plantation expansion on deforestation rates also depends strongly on how the land was used before the plantation. Replacing a mixed-species tropical forest with a planted forest has different impacts than one planted on land previously used for cattle grazing. Overuse and contamination of water is a real issue in many regions, but plantation companies would argue that establishing buffer zones and practices to limit fertilizer leakage can mitigate those risks.

There are also many criticisms of large, ambitious tree planting programs as a climate solution, such as the Trillion Trees Campaign. Many of these echo criticisms against plantations in general - that such projects destroy natural ecosystems, deplete water, damage agriculture, and push people off of the land. In addition, a major critique is that such projects distract from more urgent priorities of protecting existing forests and reducing fossil fuel use. However, the counterview to this point is that we need all solutions at once, including planting trees where appropriate. Many such projects set targets of how many trees to plant instead of how many survive over time, or more importantly, whether they provide the desired benefits. There has also been strong pushback against proposals to plant trees in grasslands, where trees are not part of the natural ecosystem, and where actual restoration would entail restoring grassland rather than introducing trees.

Finally, Taylor summarized a number of proposed tools for addressing these concerns and reducing negative impacts of plantations on people and the planet. One of these is ensuring ethical supply chains so that plantations do not replace natural ecosystems, nor displace and exploit people. The Accountability Framework is one resource to help certify ethical supply chains in forest products. Another approach is the High Conservation Value Network, which helps identify areas with high conservation values and approaches to manage them effectively. In response to pushback against initiatives like the Trillion Trees Campaign and tree planting as a climate solution, WRI has been developing approaches and frameworks to help guide project implementation. Monitoring tree survival rather than tree planting, as well as socioeconomic impacts, can help improve outcomes of tree planting projects. Additionally, WRI released a set of 10 Golden Rules for Restoring Forests, which include selecting previously forested areas, using natural regeneration where possible, mixing species to improve biodiversity, and involving local communities in restoration projects.

A planted agroforest in Bahia, Brazil, with rubber trees in the overstory and cacao in the understory. Photo by Thomas Harris.





VIDEO

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Communities and Local Involvement

Presented: October 25, 2022



Minnie Degawan

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MINNIE DEGAWAN, Director of Indigenous and Traditional Peoples Program CONSERVATION INTERNATIONAL

Summary by: Isobel Campbell and Michael Culbertson

Minnie Degawan is a longtime activist, member of the Kankanaey-Igorot Indigenous peoples, and director of Conservation International's Indigenous and Traditional Peoples Program. Her webinar addressed community and local involvement in planted forests, speaking about the relationship between Indigenous communities and planted forests in the Philippines.

Degawan began by emphasizing the relationship between Indigenous peoples and forests. For some, ancestors are believed to reside in the forest and guide the community. When forests are strong, the community is assured food and security. Maintaining the strength of the forests requires knowledge of species composition, species habits and distribution, and harvest timing. Thus, forests do not exist in a pristine and untouched state. Instead, they are managed by activities that maintain the balance between the forest and people. Elders go into the forest to plant trees where it is disturbed, women become experts on smaller plants, and men work with the larger trees. The seasons are marked based on the relationship between forests and the community, and rituals are conducted at the sacred forest sites, affirming kinship. Young men are taught to recognize forest indicators that show what their community can expect later that year.

Degawan described how where she comes from in the Cordillera Region, the forests are owned by the clan, and each member of the clan is expected to plant trees in the forest. When a child is born, the grandparents plant trees on behalf of the child to ensure that the child's needs will be taken care of. In doing so, they also strengthen their claims to ownership of the forest. These biodiverse planted forests meet peoples' physical, emotional, and spiritual needs, whereas other types of planted forests, such as palm oil plantations, do not satisfy those conditions and therefore may not be considered true forests by the communities.

Extractive industries like mining are the greatest threat to relationships between Indigenous peoples and forests in the Cordillera. Agricultural plantations for palm oil and pineapple also threaten mountain areas. Government administrations have failed to recognize Indigenous ways of knowing or address problems of inclusion and sustainability.

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Degawan recommended that management should remain local and community-based. She noted the climate crisis is urgent but Indigenous people are strong because their community has its own governance mechanisms for dealing with issues specific to their context. Degawan urged viewers to stop looking at Indigenous people around the globe as homogenous but see them as diverse. Conservation projects must also include adjacent communities, small forests, and finer scale degraded areas within larger conservation areas, and they must be developed at the local level.

Degawan explained why many reforestation efforts fail despite their huge amounts of funding. Often, they are not aligned with the values and needs of the community. Governments hire outside consultants who bring in exotic species, and communities do not understand the project's purpose, nor the relationships of actors involved in the project.

Degawan urged the audience to look at the forest from the perspectives of the local communities. We must ask why restoration is being conducted and how that motivation relates to what is planted, how it is planted, and by whom. Reforestation must go beyond meeting society's physical needs, but must also incorporate the community's values and recreate the relationship between the community and the planted forest. By involving the community, we can ensure the greatest chance of successful restoration.

Degawan then expressed concerns that reforestation associated with carbon projects can negatively impact the community's values, promising compensation while changing the forest from being seen as a place where elders reside to a carbon sink for economic benefits. REDD+ has evolved to include new considerations, but the underlying framework remains inherently unequal. Donors provide resources under non-disclosure agreements and buyers of the carbon credits are hidden from the communities. This conflicts

Despite funding being available for reforestation, mountains like these remain denuded because local communities are not involved in the planning process. They do not understand the motivations for reforestation, and the projects are detached from their needs and cultures. Photo courtesy of Minnie Degawan.

with Indigenous understandings of relationships and reciprocity. There is also a lack of communication with Indigenous people about what carbon offsets actually are. People are concerned that carbon projects may be taking away the trees' spirits, and educational and political systems fail to incorporate Indigenous knowledge and values.

Some Indigenous-owned carbon projects based on previously recognized land rights are successful, empowering people to engage and negotiate benefit-sharing mechanisms. However, projects should not assume that they have all the solutions and that Indigenous people are beneficiaries. Instead, they should work with Indigenous peoples, incorporate what they think, and be honest about the inability to meet all needs. If these conditions are met, then REDD+ can be a viable option for financing development.

When asked about the factors that prevent fragmentation in Indigenous-managed forests, Degawan responded that Indigenous value systems are generally more concerned with the community, whereas capitalism and commercialization are more concerned with the individual. Also, in the Muyong system in the Philippines, only the eldest child can inherit the forest. While this may initially appear inequitable, it ensures that the forest is not divided. In other areas, the forest is communally owned by a clan wherein each member is involved in its management and expected to take what they need, also preventing fragmentation.

Degawan had not yet formulated a position on granting legal personhood to natural features like rivers and forests. However, she noted that designating spokespeople for the river or forest may be used to deny rights to communities. To her, the rights of forests and people should always be included together.

Moving forward, Degawan urged viewers to understand and accept that forests are living beings, cared for by Indigenous peoples. Strengthening Indigenous peoples' participation in discourse and management is a necessary first step toward local, community-based forest ownership and oversight.

Some tree plantations, such as this one in Indonesia, include conservation or restoration areas within the landscape matrix. Photo courtesy of TFD.







Investment in Forest Restoration Utilizing Planted Forests

Presented: November 1, 2022



Mark Wishnie

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MARK WISHNIE, Chief Sustainability Officer BTG PACTUAL TIMBERLAND INVESTMENT GROUP

Summary by: Grace Bachmann and Diana Satkauskas

Mark Wishnie, chief sustainability officer of BTG Pactual Timberland Investment Group, presented his thoughts on how investing in planted forests can support forest restoration, specifically in Brazil. He oriented the audience to the global wood supply market by pointing out that 300 million hectares (ha), or 7% of the total global forest area, are planted forests. Only 3-3.5% of the total global forest area is commercially planted forests, yet these forests provide almost half of global industrial roundwood. Based on these statistics, Wishnie said it is clear that these small areas of intensively managed forests play a large role in the global production of wood products. He added that globally there is minimal overlap in areas where forests are planted and where deforestation is occurring. Wishnie then shared that the Food and Agriculture Organization of the United Nations (FAO) estimates that the consumption of primary forest products will increase by more than a third over the next 30 years, which may even be an underestimate as we transition to a global circular bioeconomy.

Planted forests in Brazil are about 0.2% of the total global forest area, and they grow extraordinarily fast over large scales. In 2020, they produced about 9% of the total global roundwood. They are very productive systems that sequester carbon quickly and produce many forest products at a low cost, so planted forests will likely increase in Brazil as demand continues to rise.

A mosaic of agricultural crops and forest plantations in Ch Photo courtesy of TFD.

Wishnie then posed the question, "what is different in the world today versus a couple of years ago?" He stated that the urgency around climate change has heightened considerably because we are expected to severely exceed warming limits deemed safe by the global scientific community. Because global warming events have directly impacted many businesses and their supply chains, there has been a shift in the investor landscape to respond to those threats. Wishnie explained that this is apparent by the increase in global Fortune 500 companies that have committed to reducing or eliminating emissions by 2030. Five or six years ago, only about 5% of companies had made commitments, whereas about 40% of companies have now committed. Investments that can deliver net positive impacts on biodiversity, nature, and communities are becoming mainstream, significantly increasing capital and positively driving companies to find new solutions.

Five years ago, it was established that natural climate solutions (NCS) are a viable investment opportunity for addressing climate change. It was recognized that nature is part of the solution to reach our climate goals, and reforestation is by far the greatest NCS opportunity. Wishnie explained that reforestation represents almost half of the total NCS opportunities because it is the only scalable carbon removal technology available today. The next step is to learn how to incentivize people to plant forests and how to plant trees without exacerbating negative environmental consequences. Wishnie also emphasized that NCS only impacts climate if deployed at scale, so it is imperative to understand how large-scale changes positively and negatively impact landscapes.

Wishnie then explained that planting strategies in Brazil include natural forest restoration adjacent to highly managed timber production systems. It is common for businesses to compensate for their carbon dioxide emissions by purchasing "carbon offsets," essentially supporting projects that lower emissions or remove greenhouse gases from the atmosphere. According to market participants, buyers prefer to purchase offsets that have significant positive benefits to nature and people. The average price of carbon offsets involving afforestation, reforestation, and avoided deforestation are the highest on the market. Wishnie stated that it is unclear how the market will persist, but the prices of these offsets are high enough to begin supporting management decisions that incorporate other outcomes, complementing timber production.



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Planted forests have played a prominent role in the conservation and restoration of Brazil's forests. For every hectare of the 9.5 million ha of planted forests in Brazil, on average 0.6 ha of forests are protected or restored. This is driven by local laws and regulations, as about 40% of planted forests are certified by third-parties, such as for the Forest Stewardship Council. Increases in restoration commitments by private companies indicate that it may be possible to monetize increasing areas of restoration and conservation in commercial systems and continue building social license to operate for the sector.

Potential contribution of the land sector to climate change mitigation through 2030 (millions of tCO₃e per year)²



Of known natural climate solutions, reforestation shows the greatest carbon mitigation potential. Figure courtesy of Mark Wishnie, data from Griscom et al., 2017.

Wishnie later identified five key opportunities for investments in planted forests in Latin America to help drive forest protection and restoration:

- 1. Bringing forest properties into compliance with laws and certification standards could create positive outcomes from the simple market-driven expansion of well-managed planted forests.
- Increased premiums for high biodiversity carbon offsets could incentivize the use of restoration to increase connectivity between properties. Greater connectivity would increase the landscape's biodiversity value and subsequently marketable offset prices.

- Greater demands for climate-, nature-, and communitypositive investments could drive innovation and the integration of restoration, with associated social and environmental benefits, in more projects.
- Emerging frameworks for assessing and potentially evaluating direct impacts of restoration on nature could favor management of and investment in systems that demonstrate net positive impacts on nature.
- 5. Efficiency could be increased in existing systems. It is possible to get 1% more out of almost any system through optimization and prioritization.

Wishnie ended his presentation by expanding on building the social license for the forest sector. Wood is seen as the most renewable resource, but it is strongly associated with deforestation, and the forest products sector is seen in an unfavorable light. The general public may be concerned they are driving deforestation or other adverse environmental consequences. Because of the social license gap between the material and the industry producing it, people in power, such as policymakers and regulators, support increased wood use with caution. The integration of restoration into planted forest systems can address the social license gap by demonstrating that planted forests provide renewable material for the bioeconomy and support the restoration of ecosystem function across landscapes.

Restoration and tree farm layout

30% protected and restored natural forest



In Brazil, trees are farmed in areas most suitable for production and forests are restored in areas that can provide greater ecosystem services, such as along waterways and on steep slopes. Figure courtesy of Mark Wishnie / TTG Forestry Services.





Societal Concerns and Planted Forests

Presented: November 8, 2022



Marcus Colchester

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MARCUS COLCHESTER, PhD, Senior Policy Officer FOREST PEOPLES PROGRAMME

Summary by: Manny Flores

Marcus Colchester, senior policy advisor for the Forest Peoples Programme (FPP) and board member on the Forest Stewardship Council (FSC), presented a talk exploring the impacts that plantations have on Indigenous communities. The session focused on ways in which FSC has attempted to reduce negative outcomes that planted forest development has had on Indigenous peoples.

Colchester began by stating how forest plantations can generate wealth and transform local communities, though this change is not always for the better. Sometimes, plantation forestry can affect Indigenous and local communities through land grabbing, land concentration, human rights abuses, gendered impacts, and losses of food security. These negative outcomes have led to increased conflict between corporations and the local communities impacted by harmful business practices.

Radiata pine sawlogs, harvested by a Maori company that grows market-oriented species in planted forests using traditional Maori principles. Photo courtesy of TFD.

Colchester then shared what FSC has done to mitigate these impacts. The Principle and Criteria (P&C), first generated by FSC in the 1990s, includes safeguards to provide incentives for companies to resolve land conflicts and prevent land grabbing. worker exploitation, and labor rights violations. FSC also has guidelines to prevent human rights abuses, such as ensuring that local livelihoods are preserved, reducing gendered impacts, and reducing the use of agrochemicals. However, while these specific provisions have been part of the certification process for FSC, there are still critical holes in the current P&C that fail to address the concentration of land ownership, reduced employment opportunities, and losses of choice in crops grown, sometimes associated with planted forests. Nonetheless, Colchester made it clear that FSC's P&Cs are evolving standards that are continually refined through stakeholder processes such as The Forests Dialogue, New Generation Plantations, and FSC itself.



A violator of an FSC certification has the "Right to Remedy," or the opportunity to remediate the consequences of their infraction and re-establish the conditions that would have existed had the infraction not occurred. Image courtesy of Marcus Colchester.

Colchester then highlighted the need for Intensively Managed Planted Forests (IMPFs) to provide economic benefits to local communities and the nations in which they reside. However, a review conducted by TFD found a general trend that the larger the IMPF project and the less capacity a national government has to control IMPFs, the higher the chance that social costs will be incurred and the IMPF project will not generate social benefits.





Harvesting site in a commercial eucalyptus plantation in Riau, Indonesia. Photo courtesy of TFD.

Colchester then noted that while these trends persist, there is also an increased risk of harm to Indigenous communities through further intensification of forest plantation practices.

Advancements in tree improvement technologies and intensified plantation development could increase the risk of negative impacts on Indigenous communities and farmers. Thus, one of FSC's current challenges is to ensure that plantation intensification develops in a way that benefits local communities while also making up for past harms conducted by the corporations in charge of these operations.

This led to a discussion on the "Right to Remedy," which is the idea that when a company violates an international human rights law, they must make up for their infractions by engaging with victims, gaining consent, and undergoing an agreed upon process that remedies the situation. If they do not follow this process, they risk public condemnation. These remedies can take many forms, apply to all legal persons, and can be fulfilled by businesses and states that cause negative impacts on local communities. FSC has worked toward guidelines that provide a clear set of instructions for businesses or states remedying past harms toward communities.

A A hopical mosaic landscape of eucalyptus planted forests and n Photo courtesy of Rod Taylor? WRI.

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Next, Colchester discussed examples of forest plantations' negative impacts on Indigenous communities. The first example included the Toba Batak people of North Sumatra, Indonesia. The Toba Batak people have stewarded their forests and harvested and traded frankincense from their trees for 2,000 years. However, because this community's land ownership had not been recognized by the government of Indonesia, 180,000 ha of land was given as concessions to a forest plantation company. These lands were then cleared, ultimately eradicating Indigenous frankincense trade. In response to this, the Toba Batak people, with support from FPP, made an appeal to the International Labour Organization to report discrimination against them. This action eventually led to the Toba Batak people being formally recognized as an Indigenous community. However, the harms have not yet been fully remedied to make up for the lost forests and trade derived from the forests, and FSC disallowed forest conversion in Indonesia after 1994. As deforestation continued, major Indonesian plantation companies lost FSC certification.

Since 2010, FSC has been working toward developing a framework that would allow companies to re-enter certification as long as they first remedy social and environmental harms. The goal behind this re-certification process is to promote the right to remedy amongst businesses and states that have been found to conduct past harms.

Colchester concluded his talk with an example of companies attempting to remedy local communities' loss of access to ancestral areas. in Riau after their peat swamps were drained, canals and roads blocked, and streams polluted by plantation development. The Riau people are currently in communication with companies, attempting to regain access to sacred areas, restore ownership rights, and receive supplemental aid in order to improve local farming and fishing economies. Colchester explained that the community is still open to developing good relationships with companies that committed to involving the whole community around land agreements and land-sharing.

Left and previous page: A young commercial eucalyptus plantation in Riau, Indonesia. Photo courtesy of TFD.

Innovation and Adaptation in the Planted Forests Sector



Presented: November 15, 2022

FRANCISCO RAZZOLINI, Chief Technology Officer KLABIN

Summary by: Arun Dayanandan and Mary Katherine DeWane

Francisco Razzolini, chief technology officer of Klabin, a pulp and paper company in Brazil, discussed recent advances in silvicultural and chemical manufacturing technologies related to plantation forestry in Brazil. Like many of the prior speakers in the series, Razzolini spoke to the pressing challenges of climate change, increased demand for forest products, and the emergence of a circular bioeconomy. He highlighted how major pulp and paper companies can meet the demand for forest products while maintaining areas of natural forests that act as carbon sinks and habitats for native species. Razzolini began his talk by illustrating the current demand for wood products worldwide.



Francisco Razzolini

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According to the FAO, approximately 50% of global roundwood is used for fuelwood, 30% is used for sawlogs, and about 20% for pulpwood. Given the forecasted growth in demand for wood products, the total harvested land area needed to meet this demand is also set to increase. Razzolini argued that by intensifying production on Intensively Managed Planted Forests (IMPFs), the hectares of a harvested area will not need to increase at the same rate as demand.

After placing demand for roundwood in a global context, Razzolini introduced his company, Klabin, which currently has 280,000 hectares of natural forest preserves and 287,000 hectares of planted pine and eucalyptus forests in the Mata Atlantica region of Brazil. Similar to Weyerhaeuser, represented by Ara Erickson earlier in this seminar series, Klabin is a vertically integrated forest products company. Klabin manages its planted forests for fast-rotation pulpwood. The main products from Klabin's mills are bleached pulp (hardwood, softwood, and fluff), paper for packaging (kraft liner board and coated board), and packaging (corrugated boxes and industrial bags). Klabin is working in the areas of innovation and sustainability at both the forest and processing levels.



Increases in forest productivity would reduce the area of forests that must be planted annually to meet global wood demands. Figure courtesy of Francisco Razzolini / Klabin.

At the forest level, Klabin is increasing productivity through precision silviculture, increasing site quality, and improving planting stock genetics. With precision silviculture, mean annual increment (MAI), a measure of forest growth over time, has increased in both pine and eucalyptus forests over the last few decades. Klabin uses remote sensing and on-the-ground, tree-level monitoring to collect data about the impact of silvicultural treatments on tree growth and yield. From a genetic perspective, Klabin produces site-specific seedlings in their nurseries through a combination of cross-breeding, artificial selection, genome-wide selection, and genetic modification technologies such as CRISPR. Improved seedlings allow for reduced inputs of herbicides and silvicultural treatments while promising increased growth. Razzolini also mentioned that as weather regimes geographically shift due to climate change, site-specific seedling stock can be used to adapt to changes without losses in production.



The lowest value forest products (pulp and paper) are at the base of the pyramid and highest (nanocellulose and pharmaceuticals) are at the top. Figure from Maximo et al., 2020.

Post-harvest, Klabin is in the process of innovating pulp and paper production and developing new value-added products from biorefineries, including carbon fibers, biofuels, and pharmaceuticals. As we have heard from several speakers in this series, Razzolini spoke to the importance of intensively managed planted forests to the circular bioeconomy and to the transition away from fossil fuels





and other materials with high carbon emissions. Many of the forest byproducts that Razzolini mentioned could replace bio-products are currently being produced with corn and sugarcane. Woodbased biofuels are less carbon-intensive than those created with annual crops, and they offer additional co-benefits to wildlife and soil carbon storage.

Some of the highest value-added wood-based products are chemical compounds, such as nanocellulose and lignin, among others. Cellulose can also be used to produce compounds such as ethanol, and hemi-cellulose can be used to make barrier compounds that repel water and odors from paper and packaging products. Pine extracts have long been used to make turpentine, but other high-value bioactive chemicals, such as tall oil, can also be extracted.

Razzolini ended his talk with the case study of the PUMA project. This includes a biorefinery, a school that trains workers in forestry and mill work, and other strategies for involving smallholders. The PUMA mill runs on 96% renewable energy, and Klabin is working to reduce their dependence on fossil fuels throughout the entire supply chain. Technological advancements at the PUMA mill have enabled Klabin to decrease their total land harvested while increasing pulp production.

Throughout his talk, Razzolini highlighted the potential for intensively managed planted forests to meet the forest-product needs of a growing global population while protecting natural forests and the plant and animal populations in biological corridors. Not only does Klabin focus on innovations in forestry and operations, but they also focus on developing their human capital by establishing technical schools, involving local smallholders, and employing a high proportion of women in their mills and throughout their company.

In this series, we have heard from several speakers about the circular bioeconomy, the protection of natural forests alongside planted forests, and the involvement of local communities in forest management and forest product supply chains. Francisco Razzolini's talk builds on these themes while introducing some of the technological and scientific advances that are improving efficiencies in silviculture, paper production, and value-added product engineering.

Longleaf pine plantation in Georgia after prescribed fire. Photo by Thomas Harris.

Conclusion

By: Ryan Smith

The Yale Forest Forum's speaker series, "The Future of Forest Products in a Changing Climate: (Re)Considering Planted Forests for the 21st Century," brought together leading experts to discuss challenges associated with planted forests and opportunities for plantation forestry to meet society's environmental and social needs. Despite historic controversies surrounding tree plantations, a growing global population with an increasing demand for wood products positions planted forests to play a critical role in meeting future resource demands.

Speakers in this series presented numerous ways in which stakeholders can learn from plantation forestry's past and provided innovative pathways for realizing tree plantations' economic, social, and ecological potentials. Planning processes such as the landscape approach used by New Generations Plantations, alongside appropriate environmental and social safeguards, can optimize the functions that plantation forestry can serve in a landscape. Regulatory frameworks such as Brazil's forest law can help scale the benefits provided by plantations. However, Indigenous and local communities must be central decision-makers in planning processes that affect them, and historic wrongs will need to be addressed to regain their trust. As Neves Silva pointed out, a key challenge that remains is the development of sources of capital that support the capacity of planted forests to provide social and environmental co-benefits. This speaker series sought to bring diverse voices from the forest sector together and unveil ideas for addressing modern challenges, such as those posed by plantation forestry.



A longleaf pine plantation in Georgia, United States.

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