BRU
Bamboo & Rattan Update
INBAR
Sharing the latest news and activities from the bamboo and rattan sectors

FROM SHORELINE TO SHELTER: THE RISE OF BAMBOO

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Cover Image
Fish swimming by bamboo reefs in the Philippines. Credit: Anthony Into.

Editorial Team
Hao Ying
Austin Smith
Leticia Robles

Contributors
Anthony Into
Pablo van der Lugt
Nicole Nicholson
Sebastian Kaminski

To Submit
www.inbar.int/bru-magazine/
bru-magazine@inbar.int

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B R U

EDITORIAL

Welcome to the first issue of the* Bamboo and Rattan Update *for 2026, which shines a light on ocean life, resilient construction and the places we call home.

Bamboo and rattan have been essential components of human civilization for thousands of years, woven into baskets, built into homes, bundled into rafts. But what's happening with these materials today, in laboratories and construction sites and coastal waters around the world, is something most people haven't heard about yet. These are no longer folk materials only suitable for craft markets. They are emerging as credible solutions with the scalability to tackle some of the most urgent problems in sustainable development, be it restoring degraded marine ecosystems, reducing emissions from construction or building affordable homes to meet rising global demand. This issue of the *Bamboo and Rattan Update* takes a hard look at these three frontiers.

The first article takes us to the coast of Southern Leyte in the Philippines, where the French NGO Scaph Pro Philippines is deploying artificial coral reefs made entirely of bamboo. Coral reefs, which are extraordinary underwater ecosystems sometimes called the "rainforests" of the sea, are disappearing around the world. Rising ocean temperatures, acidification, pollution and destructive fishing practices have devastated reef systems worldwide. Artificial reefs have long been used as a conservation tool, but the choice of material matters. Here, it turns out that bamboo is well suited to the task at hand. Bamboo is a strong material with mild natural antimicrobial properties, helping it resist early decay in seawater. Its biodegradable nature makes it a strategic choice for reef restoration — providing temporary support for coral growth while allowing the ecosystem to transition into a fully natural, self-sustaining reef. Its complex morphology, including crevices, hollow tubes and irregular surfaces, mimic the structure of natural coral habitats. This provides vital shelter and breeding grounds for fish, crustaceans and invertebrates. The project, operating in partnership with the local municipality of Silago, has already immersed 125 modules in the Balagawan-Mercedes marine sanctuary. Within twenty days of the first deployment, micro-algae, hydroids and mollusks had already taken hold. Longfin batfish arrived soon after. Though the project is in its early stages, it is already tangible proof that bamboo can play a strong role in marine restoration, and that sustainable material choices do not stop at the shoreline.

From the seafloor to the construction site the next article confronts a problem most people know about but few have

considered from a construction angle: The staggering amount of plastic use in the built environment. Global plastic production now exceeds 400 million tonnes per year, with the construction sector alone accounting for roughly 18% of that demand. PVC flooring, polyurethane insulation, wood-plastic composites for decking and cladding are everywhere in the built environment. Recycling is an immense practical challenge. In fact, less than 10% of all plastics ever produced have been effectively recycled. The rest ends up in landfills, incinerators or the ocean. The feature makes the well-supported case that engineered bamboo products, such as strand-woven and thermally modified bamboo and bamboo fiber boards can substitute for many emissions-heavy materials. The carbon math works in bamboo's favor at every stage, since it stores biogenic carbon rather than releasing it, reaches maturity in annual timescales, not decades, and at end of life it can be re-utilized rather than persisting as toxic waste for centuries. The case for bamboo as a green industrial alternative is persuasive indeed.

The final article takes a close look at bamboo housing in Latin America. A team of researchers traveled to Colombia and Costa Rica to investigate bamboo homes built between 23 and 38 years ago. The composite bamboo shear wall system, or CBSW, is a modernized descendant of the traditional Latin American *bahareque* method, consisting of a bamboo and timber frame covered with a matrix of cane or mesh and rendered in cement mortar. More than 10,000 of these homes have been built across Colombia, Costa Rica, Ecuador, El Salvador and beyond. CBSW construction is now included in national building standards in Colombia, Ecuador and Peru, as well as in the international ISO 22156:2021 structural design code. The visits covered 39 homes in total, painting a broadly positive picture. Boron-treated bamboo proved highly resistant to termites and beetles. By and large, home residents trusted their homes, especially in earthquake country, with water damage and several other issues as targets for future design improvements. The article offers specific, practical guidance on how to solve these issues. Finally, it concludes that with the right design approach, a CBSW home can last 50 years with minimal maintenance. In a world where hundreds of millions of people still lack safe and affordable shelter, that is a fact worth remembering.

This issue highlights three stories united by one plant. Bamboo rarely makes the front pages of mainstream sustainability debates. It is high time we gave it the attention

THE EDITORS

CAN BAMBOO REPLACE NATURAL CORAL REEFS?

A diver securing bamboo poles at the Balagawan-Mercedes marine sanctuary in the Philippines. Credit: Anthony Into.

Somewhere at the side of a coastal road in a small village in Southern Leyte, the Philippines, it's not unusual to see a group of men busy assembling what look like triangular structures made of bamboo. These men are building artificial coral reefs — yes, you read that correctly! The project is part of a marine restoration effort in the village of Balagawan, spearheaded by Scaph Pro Philippines Oceanographic Research, an NGO based in France.

Are artificial reefs really needed?

Referred to as the "rainforests of the sea," coral reefs are underwater ecosystems made up of colonies of tiny marine invertebrates called coral polyps. These reefs form over long periods as these organisms, in symbiosis with algae, create calcium carbonate structures that provide habitats for a diverse array of marine life.

Unfortunately, natural coral reefs are dwindling. Rising sea temperatures due to climate change, increased ocean acidity, pollution from runoff and various sources, overfishing, destructive fishing practices and physical damage caused by human activities all contribute to the decline of coral reefs worldwide.

This is where artificial coral reefs come into play. Through the years, artificial reefs have emerged as a critical tool in marine conservation efforts, aiming to restore and preserve delicate marine ecosystems. Because of this, one of Scaph

Pro's main objectives in the Philippines is to develop artificial reef structures.

Sustainable material

Bamboo is not a tree. It is a type of grass belonging to the family Poaceae, which includes other grasses like wheat, rice and sugarcane. With a remarkable growth rate, bamboo is a great option for creating artificial reefs as it allows for swift construction and deployment. Scaph Pro Philippines' artificial reef project also supports the bamboo economy of the nearby Municipality of Silago, which is home to an abundance of this giant grass.

Bamboo is a strong material with mild natural antimicrobial properties, helping it resist early decay in seawater. Its biodegradable nature makes it a strategic choice for reef restoration—providing temporary support for coral growth while allowing the ecosystem to transition into a fully natural, self-sustaining reef.

And, bamboo is varied. Its morphological characteristics provide crevices, nooks and surfaces that replicate the intricate nature of real coral reefs. This offers various niches and hiding places for a wide range of marine organisms, including fish, crustaceans and other invertebrates. Over time, algae and other small organisms can grow on the bamboo's surface, further enhancing its likeness to natural coral and providing a food source for marine animals. As aquatic life colonizes the bamboo artificial coral, it creates a miniature ecosystem that supports biodiversity and can have a positive effect on the health of the surrounding marine environment.

Making peace with fish

Aptly named "Operation Peace for Fish," the endeavor is a way to "make peace" with aquatic animals. Jean-François Marailhac, a French marine biologist and the project manager of Scaph Pro Philippines, explained, "It is a response to overfishing because when you create artificial reefs, you provide protection for the baby fish, and the baby fish is the future." As a naturalist who has resided in Silago for over a year now, he has conducted sufficient ocean surveys that confirm reduced size and age of fish, and also depleted fish populations in the area — some indicators of overfishing.

Preparing the bamboo structures for lowering to the seabed. Credit: Anthony Into.

Artificial bamboo reefs create shelter and breeding grounds for different species. This can lead to increased fish population. Man-made reefs can also help alleviate pressures on natural fish stocks by providing additional habitats for marine life. This can reduce the strain on overexploited areas.

Built for the job

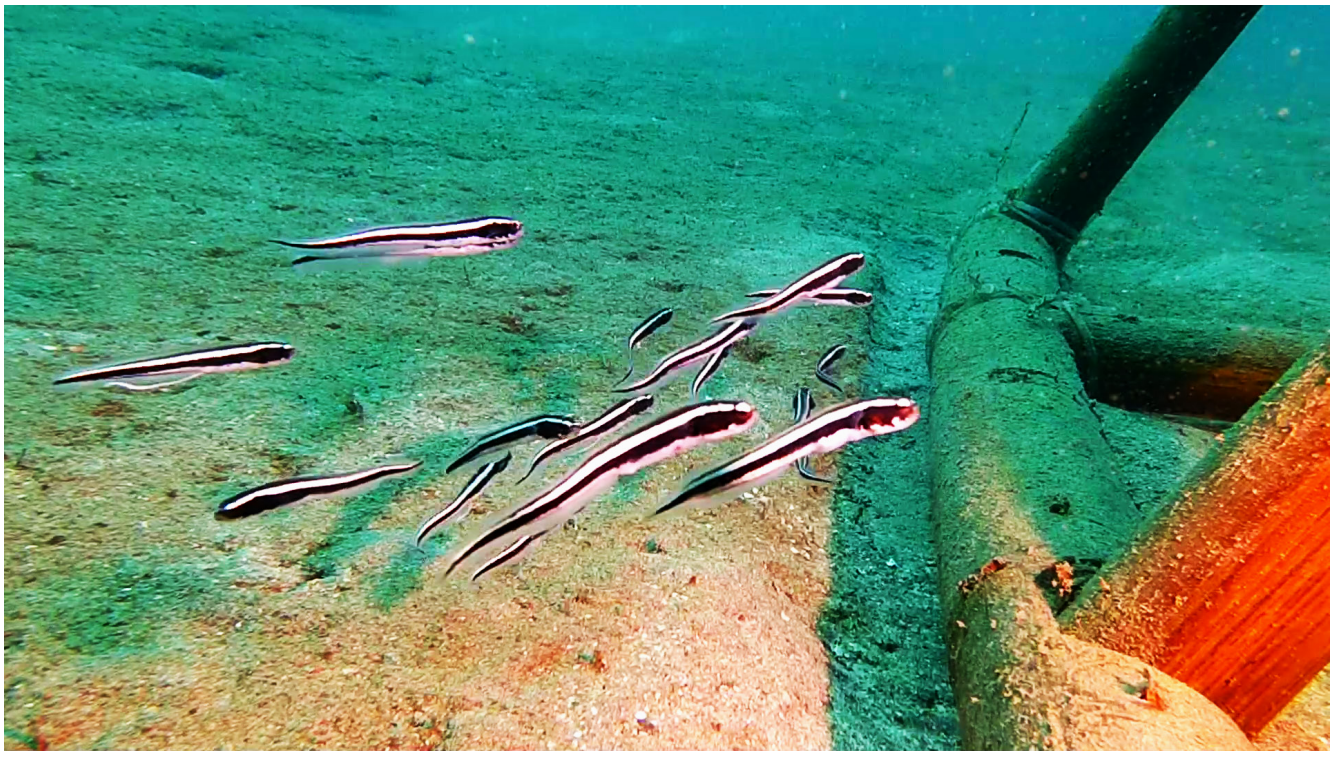
Seeing the bamboo corals (called "modules") up close, one might think they resemble trusses fit for a small *bahay-kubo* (a traditional Filipino hut). Around 1.5 meters in height, the five-sided bamboo structures are officially known as pentahedron modules. The construction process includes interlocking bamboo poles, and each set is secured with a nylon cord. The bamboo tubes that will be in contact with the ground (eventually sea floor) are filled with concrete to make sinking them underwater possible.

The other versions are called Plerogyra modules, named after the genus of the same name characterized by bubble-like tentacles. Its design is fairly straightforward. Bamboo tubes are vertically split in half. The resulting pieces are further cut horizontally to achieve 10-inch long pieces. Then they are "planted" in a rectangular bed of freshly mixed water, cement and sand. Marailhac said this module is intended for corals, offering many ecological niches.

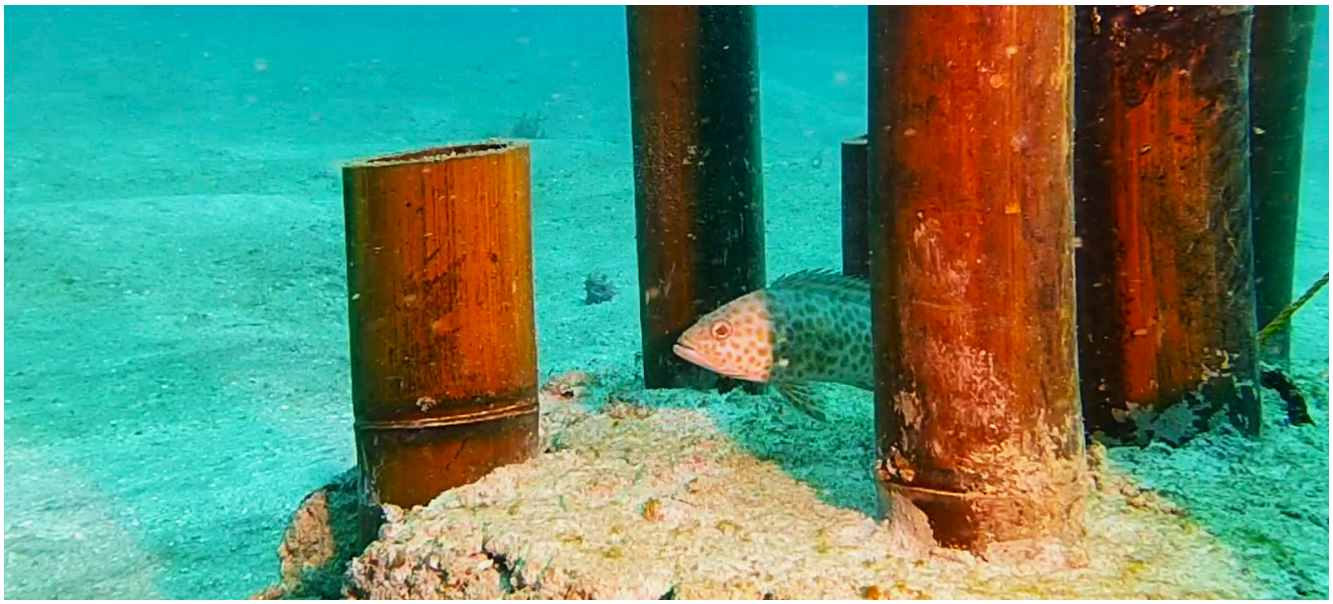
"Its height and design will allow many species of coral to find a point of colonization without being far from the cement part, thereby preserving the coral when the bamboo disappears (deteriorates) after three years," Marailhac stated. "The key element in the biological success of an artificial reef is both its architecture and its urban planning. The architecture of unit modules depends on the materials, their shape, their height, their length and their volume," he added.

Working hand in hand

Lemuel Palanca Honor, Mayor of the Municipality of Silago, confided that no one as passionate as Marailhac has ever come to Silago to help protect their marine sanctuaries. "So, I really understand now how damaged our coral reefs are, that's why when he asked us for funding, we never hesitated to give him all the help as long as we have the capacity to do it," he pointed out.



Ocean wildlife exploring the new bamboo reefs. Credit: Anthony Into.



It is hoped that the artificial bamboo reefs can act as shelter and breeding grounds for different species. Credit: Anthony Into.

What they have is a "cooperation" (Philippines-France Cooperation via Silago-NGO Scaph Pro) — a partnership that aims to address the negative impacts of overfishing, thereby supporting and enhancing marine ecosystems in the nearby municipal waters. Aside from offering his moral support, the Mayor revealed that the local government gave PHP 150,000 (~USD 2500) in funding to support the NGO. And just recently, the local government also awarded a new boat engine to be used for the operation.

Developments to date

On 13 August 2023, a raft full of heavy bamboo corals was hauled and transported to the Balagawan-Mercedes marine sanctuary during their pilot immersion. On that day, a total of 10 pentahedron modules were successfully lowered onto the seabed.

Not long after the immersion, results have been promising. Marailhac gladly reported that "Twenty days after the first immersion, life is already appearing. Micro algae, hydroids and of course their mollusk predators. A new life chain has been created." Fifteen days after these appearances, he also noted the arrival of longfin batfish around the submerged bamboo corals, and referred to those fish as "the first inhabitants marking their territory."

So far, a total of 125 pentahedron and Plerogyra modules have been successfully immersed by Scaph Pro Philippines at the Balagawan-Mercedes marine sanctuary. They are aiming to make and deploy more modules before they proceed to the next marine sanctuary (Silago has five in total).

The use of bamboo as artificial coral reefs holds significant promise in addressing the ecological challenges we are facing in our oceans. By embracing bamboo-based artificial reefs, we can contribute to marine conservation, enhance biodiversity and create sustainable solutions that benefit both marine ecosystems and the communities that rely on them. As we continue to explore innovative solutions to reef restoration, bamboo stands as a symbol of nature-inspired resilience in the face of environmental challenges.

ANTHONY INTO
Anthony Into holds a degree in Engineering. He is currently employed as a virtual assistant while also working as a freelance travel writer, with a focus on sustainability-related topics.

BAMBOO AS A SUBSTITUTE FOR PLASTICS IN THE BUILT ENVIRONMENT

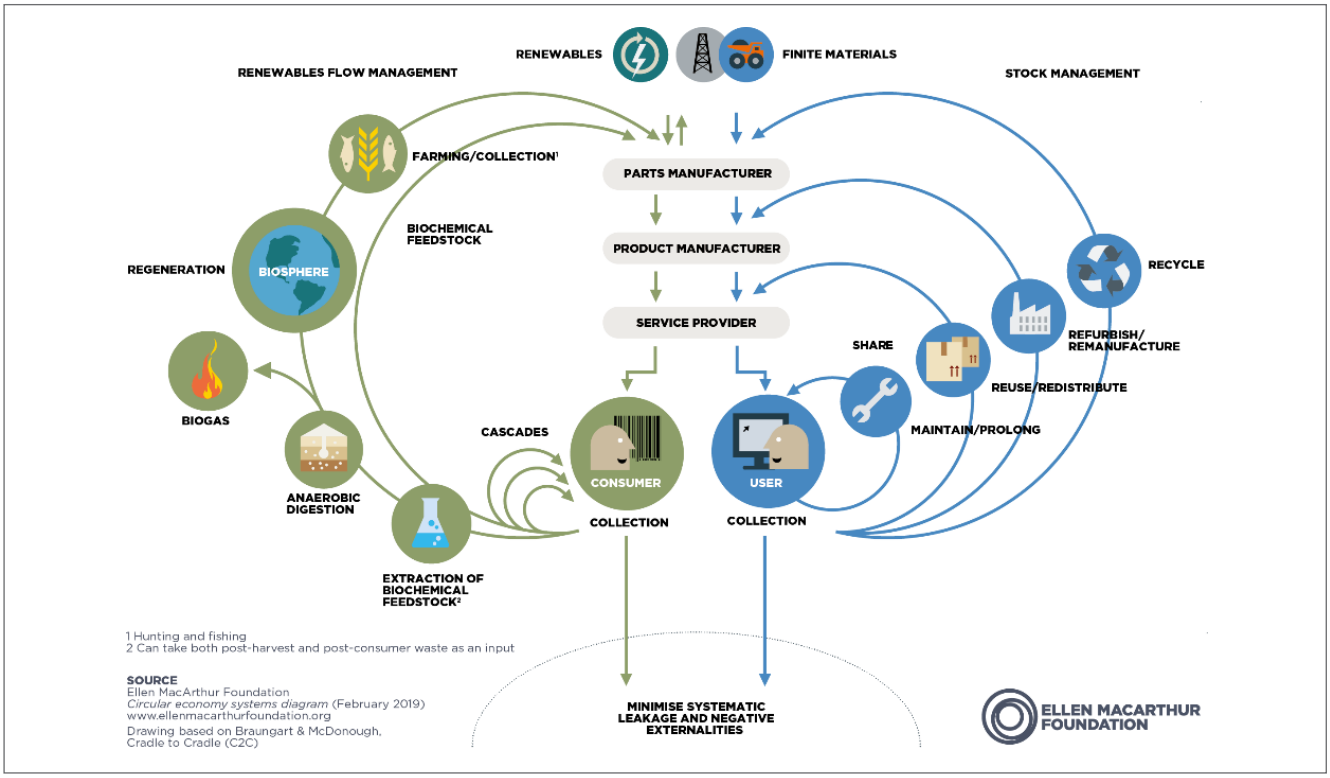
The multi-story residential building Switi in Amsterdam, designed by HoH Architects, is a compelling example of a building that consistently applies bio-based alternatives. Credit: Marcel van den Burg.

Moving from linear petrochemicals to a circular bio-cycle product.

Introduction

Plastics have become deeply embedded in modern construction. Lightweight, durable and inexpensive, they are widely used in flooring, decking, insulation, window frames and piping. Yet this convenience comes at a steep environmental cost. Global plastic production has surpassed 400 million tonnes per year, and remains overwhelmingly fossil-based. Despite decades of policy focus on recycling, outcomes remain poor: Globally, less than 10% of all plastics produced to-date are effectively recycled, while the majority have been landfilled (79%) or incinerated (12%), often releasing toxic emissions.

Even in highly industrialized regions the picture is sobering. In Europe in 2020, 35% of plastic waste after use by consumers (post-consumer plastic) was sent to recycling, 42% to energy recovery and 23% to landfill. In the United States, only about 9% of plastic waste is recycled, while the vast majority is landfilled or burned for energy recovery. An estimated 9–14 million tonnes of plastic leak into oceans and aquatic ecosystems



The circular economy model with the biological cycle on the left and the technological cycle on the right. Credit: Ellen MacArthur Foundation.

each year, severely impacting ecosystems and human health.

Beyond waste, plastics are a major contributor to climate change. According to the Organisation for Economic Cooperation and Development, the life cycle of plastics generated approximately 1.8 gigatonnes of CO_2-equivalent emissions in 2019, representing about 3.4% of global greenhouse gas emissions. These emissions are expected to double by 2060 with no policy change.

Against this backdrop, bamboo offers a compelling, bio-based alternative — especially for durable construction materials but also for short-lived consumer products. As one of the fastest-growing renewable resources on Earth, bamboo has the capacity to substitute for plastics while actively contributing to climate mitigation through carbon storage and avoided emissions.

From techno-cycle to bio-cycle

In a circular economy, materials should circulate either in the techno-cycle (non-renewable materials such as metals and plastics) or in the bio-cycle, where materials are renewable, biodegradable and able to cascade through multiple life cycles. While plastics are often promoted as "circular," in practice they rarely achieve true closed-loop recycling. Even when plastics are technically recyclable, they frequently degrade in quality with each use cycle, while their primary feedstock — crude oil — continues to deplete year by year.

A significant challenge for recycling plastics arises from the sheer variety of chemical additives incorporated into products to achieve desired performance characteristics. Plastics often contain dozens of additives per product, and broader industry analyses have identified thousands of distinct chemicals used as additives across the value chain of plastics. The complexity and diversity of these formulations make sorting and recycling technically difficult, impede high-quality closed-loop reuse and can raise toxicity concerns at the end of life.

Bamboo, by contrast, fits naturally within the bio-cycle. When plants grow, through the process of photosynthesis, they capture carbon from the

atmosphere, and this so-called "biogenic carbon" is stored in bamboo, wood and other bio-based products for their lifetime.

When used in durable applications, bamboo stores biogenic carbon for decades; it provides ample opportunities for reuse and cascading recycling; and in its natural or minimally processed form it may ultimately be safely biodegraded or composted. Crucially, bamboo is a rapidly renewable resource, reaching maturity within approximately 4–5 years, allowing continuous annual harvesting without depletion of the resource base.

Bamboo already demonstrates strong potential as a substitute for single-use plastics, including packaging, tableware and disposable consumer goods. Global trade figures show that bamboo products such as tableware and household items already represent a multi-billion-dollar market, largely replacing plastic equivalents in these short-lived applications.

However, the largest untapped potential lies in durable applications, particularly in the built environment.

Environmental impact of the construction industry

The construction sector is one of the largest consumers of materials globally, responsible for approximately 40% of total material extraction and over one-third of global CO_2 emissions when both operational and embodied carbon are considered. While much attention has been paid to the CO_2 emissions of concrete, cement and steel, plastics represent a rapidly growing share of embodied emissions.

Plastics dominate here, such as polyvinyl chloride (PVC) for flooring and cladding, polyurethane (PUR) and polyisocyanurate (PIR) for insulation, and polypropylene (PP), which is especially common in wood-plastic composites (WPCs) for decking and cladding. This is the case despite their high carbon footprints, reliance on fossil feedstocks, extensive use of chemical additives and problematic end-of-life scenarios.

Globally, the construction sector accounts for around 18% of plastics use (approximately 70 million tonnes per year). In Europe, annual demand in construction for plastics is roughly 10–11 million tonnes, with PVC as the dominant polymer, accounting for an estimated 50–60% of demand for plastics in this sector and widely used in pipes, window frames, flooring and cladding.

While PVC products often have long lifespans, recycling remains limited: VinylPlus, the European PVC industry's voluntary commitment to sustainable development, reports that around 35% of PVC waste generated in Europe is currently recycled, with the remainder incinerated or landfilled. Recycling rates for WPCs and synthetic insulation materials such as PUR and PIR are generally lower, as these materials are typically multi-material composites for which high-quality post-consumer recycling is technically difficult and not yet established at scale.

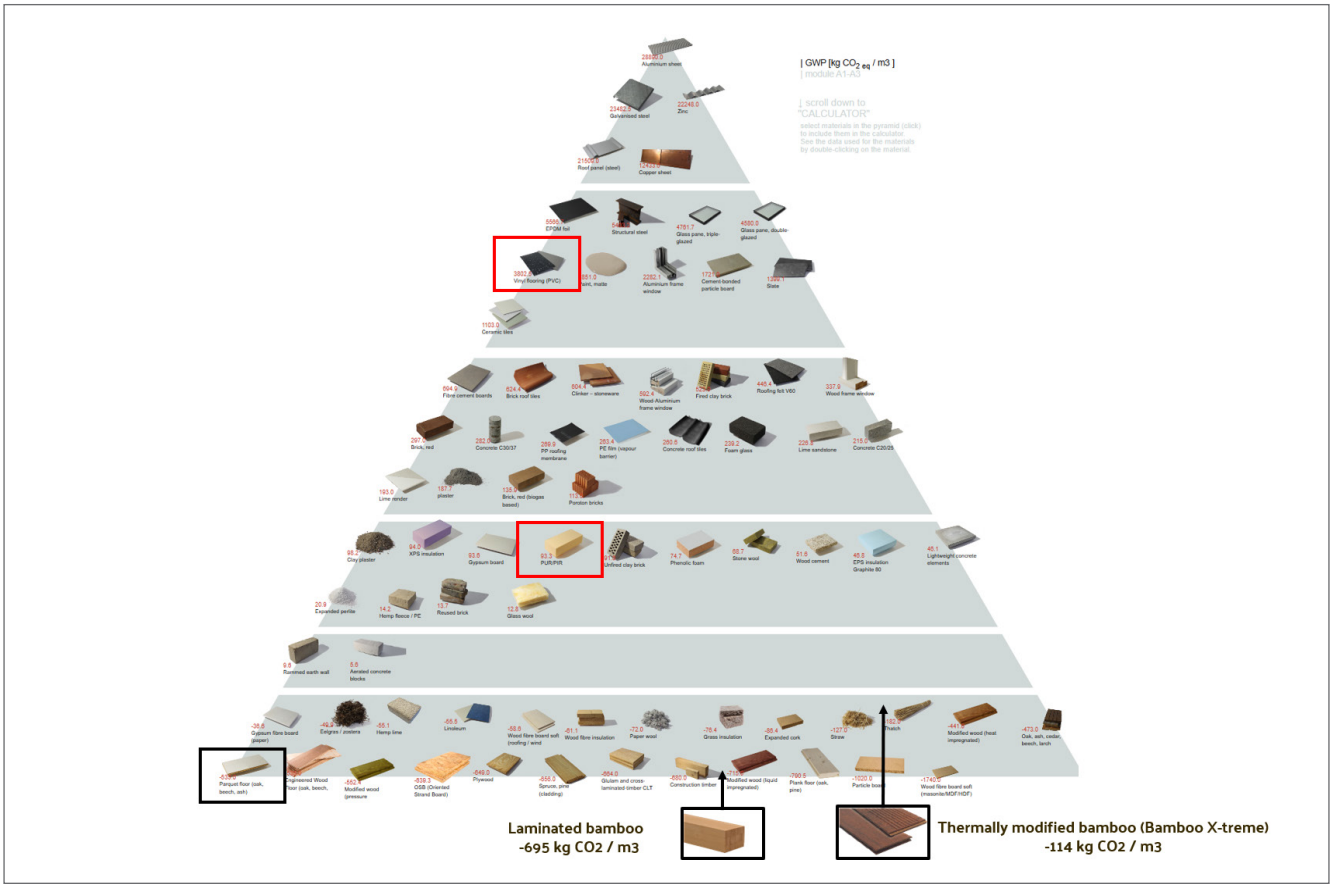
While WPCs are often marketed as recyclable, post-consumer recycling remains rare in practice due to material contamination, polymer degradation, color change and the lack of dedicated collection and recycling infrastructure. PVC faces similar circularity challenges, compounded by its chlorine-based toxic chemistry and the widespread use of additives that complicate safe recycling and limit high-quality secondary applications.

Market data from Germany's decking sector show a clear shift away from tropical hardwoods and modified wood toward WPCs, now accounting for a larger share of the German decking market than tropical hardwood. Moreover, their market share continues to grow.

In many of these applications, engineered bamboo products can provide a low-carbon, bio-based alternative that aligns far more naturally with circular economy principles.

Areas where engineered bamboo can replace plastics

Advances in bamboo processing have enabled a wide range of engineered bamboo materials suitable for demanding construction applications.



The CO_2 pyramid shows cradle-to-gate emissions per m^3 of building material, based on recent EPDs. Bamboo values are derived from publicly available EPDs for engineered bamboo. Credit: MOSO Bamboo Products.

In several cases, plastics can be directly replaced.

Bamboo flooring provides a durable, wear-resistant alternative to PVC and vinyl flooring. Bamboo fiber boards can replace petrochemical insulation materials including PUR and PIR, contributing to healthier indoor environments and improved circularity. And, thermally modified and strand-woven bamboo products offer high durability and fire performance, substituting WPCs and PVC on facades and terraces.

Bio-based materials as low impact alternatives

The carbon footprint of building materials is typically assessed through life cycle assessments and published in Environmental Product Declarations (EPDs). The CO_2 materials pyramid shown above provides an intuitive comparison of the embodied carbon of different construction materials based on recent, publicly available EPD data.

The pyramid clearly shows that bio-based materials occupy the lower end of the spectrum. Unlike fossil-based plastics, wood and bamboo store carbon absorbed during plant growth. In EPDs, this is reflected as negative emissions, representing biogenic carbon storage, which in many cases outweighs the CO_2 emissions associated with production.

Replacing PVC flooring with wood parquet or laminated bamboo flooring, PUR insulation with bamboo-based fiber boards, or PVC cladding with thermally modified bamboo therefore delivers a dual climate benefit: Lower production emissions and long-term carbon storage.

Besides its low carbon footprint, one of bamboo's most distinctive advantages — compared to techno-cycle materials and slower-growing wood — is its exceptionally high annual yield. Certain giant bamboo species can produce two to three times more usable material per hectare per

Left: Structural shell of cross-laminated timber and timber framing, wood-fiber insulation and thermally modified bamboo cladding.

year than fast-growing timber species. This makes bamboo particularly well suited to meeting the growing material demand without increasing pressure on forests or fossil resources.

Next steps

Engineered bamboo clearly demonstrates strong potential to substitute for plastics in construction, offering lower embodied carbon, a renewable feedstock and improved circularity. To fully realize this potential at scale, several challenges still need to be addressed, although recent developments indicate that progress is already being made on several fronts.

Going forward, reducing or replacing fossil-based glues remains essential to improve bio-cycle compatibility and further lower the environmental footprint of engineered bamboo, with bio-based and low-emission adhesive systems increasingly moving from research into early commercial application by some leading manufacturers.

Emerging initiatives in Europe, including take-back schemes for bamboo decking and facades, show how producers can retain material value and extend carbon storage beyond first use. This demonstrates that engineered bamboo can increasingly be embedded in a range of circular business models.

Expanding bamboo cultivation across Europe and North America can play a large role in significantly reducing transportation emissions while strengthening regional bio-economies and supply security.

For broader recommendations on improving the sustainability of bamboo products beyond engineered bamboo — including short-lived products, packaging and textiles — reference is made to the INBAR publication, *Bamboo in the Circular Economy*, which is available open-access on the INBAR website.

At a policy level, clearer recognition of biogenic carbon storage, stricter regulation of

Middle/Right: Demountable clip system for thermally modified bamboo decking. Credits: Grad, MOSO Bamboo and A-wood; Pablo van der Lugt.

plastic additives and targeted incentives for bio-based materials are crucial. Industry, in turn, must continue investing in transparency, EPDs and scalable circular business models. Now, an increasing number of producers are publishing EPDs and some even establishing take-back schemes. Making EPDs mandatory for companies above a certain size would further enhance market transparency and enable fair, evidence-based material comparisons.

Through efforts such as the Bamboo as a Substitute for Plastics Initiative, co-launched by INBAR and China, bamboo is increasingly positioned as a strategic resource for a circular, climate-positive built environment. Replacing plastics with bamboo will not happen overnight, but with the right combination of policy support, industrial innovation and market demand, bamboo can play a decisive role in moving beyond fossil-based materials.

Additional readings have been made available on INBAR's website: https://www.inbar.int/bru-7-1/.

PABLO VAN DER LUGT & NICOLE NICHOLSON

Pablo van der Lugt is a senior sustainability consultant and internationally recognized expert in bio-based materials. He is the author of several acclaimed books on bio-based construction including *Tomorrow's Timber* (2020), *Booming Bamboo* (2024) and *The Timber Truth* (2025).

Nicole Nicholson is Sustainability Specialist and Project Manager at MOSO Bamboo, working on sustainability and circularity projects for engineered bamboo products, including EPDs.

BUILT TO LAST: INSIGHTS FROM MODERN BAMBOO HOUSING IN LATIN AMERICA

Bamboo house in Colombia. Credit: Sebastian Kaminski.

Bamboo housing projects in Latin America revisited decades later, with an eye to future development.

A resilient system rooted in tradition

Around the world, people are waking up to the promise of bamboo as a high-quality building material. One innovative modern method of construction is the composite bamboo shear wall (CBSW) system. This is based on the traditional Latin American wattle-and-daub method, known as *bahareque*, engineered and improved with modern materials and construction techniques.

CBSWs consist of a frame made of large-diameter bamboo and/or timber. A matrix of cane, small-diameter bamboo, flattened bamboo, bamboo laths or expanded steel mesh is nailed to the frame. The walls are then finished with cement or lime render to form solid shear walls.

Over the past 38 years, at least 10,000 one- and two-story modern CBSW homes have been built in places like Colombia, Costa Rica, Ecuador, El Salvador, India, Mexico, Nepal, Peru and the Philippines. When properly designed and built, they are highly effective as an affordable, earthquake- and typhoon-resistant, low-carbon and durable form of housing. The technology is

also known by other names, including "improved *bahareque*," "engineered *bahareque*," "*bahareque mejorada*," "*bahareque encementado*" and "light cement bamboo frames."

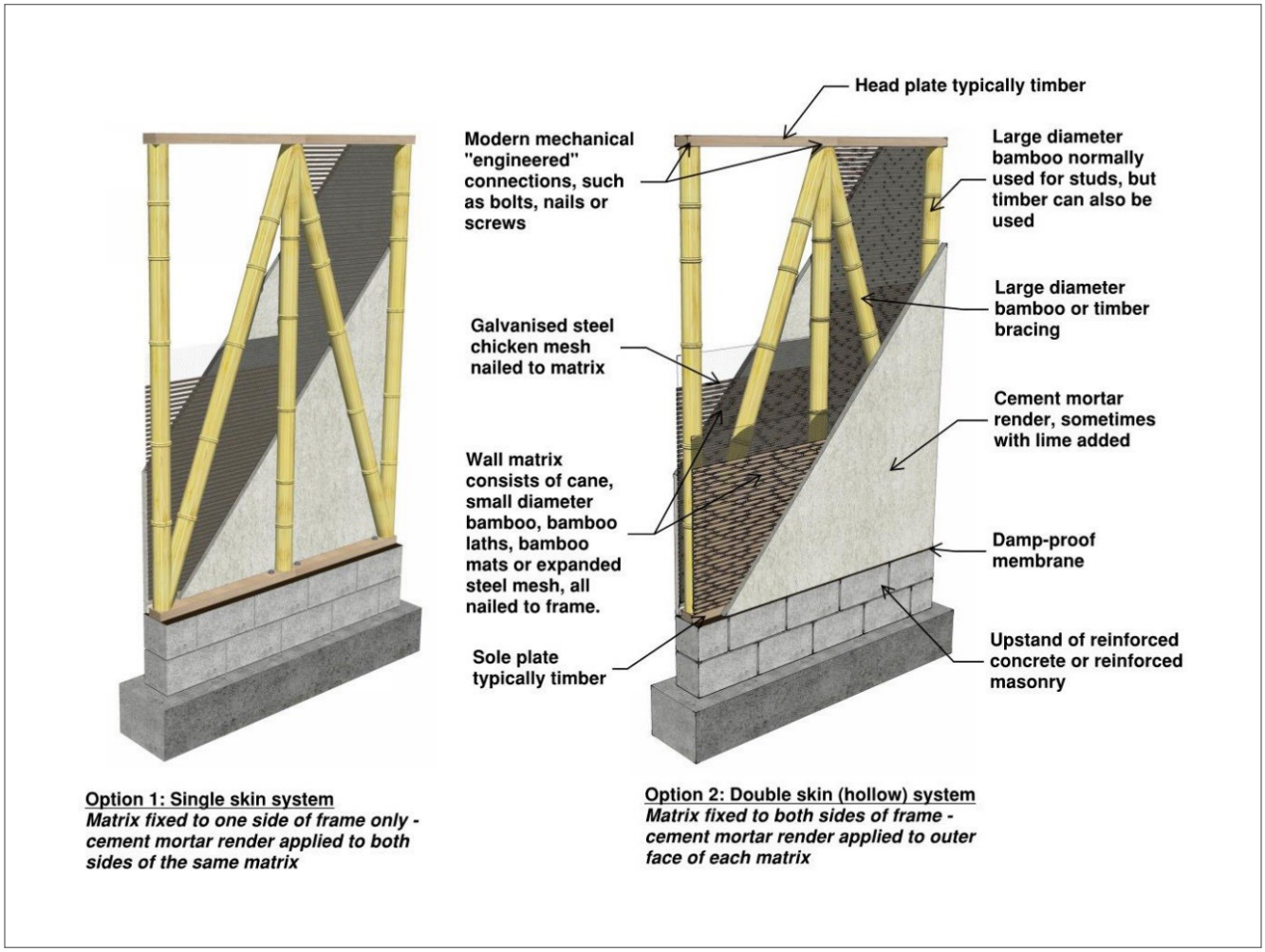
CBSWs are widely considered to be the most appropriate form of bamboo housing in highly seismic areas. The system is now included in several national building standards — in Colombia, Ecuador and Peru — and additionally in ISO 22156:2021, an international bamboo structural design code. Efforts are currently underway to incorporate them into the Philippines, Mexican and Nepalese codes.

For further reference, the recent publication *Manual for the design of bamboo structures to ISO 22156:2021* provides detailed design guidance on CBSWs.

What's the story?

As part of a joint Arup and Base Bahay initiative to improve CBSW technology worldwide, a team of structural engineers set out to evaluate CBSW homes constructed 23–38 years ago, traveling to Colombia and Costa Rica. In total, 26 homes were evaluated in Colombia, and 13 homes in Costa Rica. The aims of the project were twofold: (1) To evaluate the structural conditions of the homes, in particular the extent of rot, termite attack, beetle attack, delamination of render and roof condition, while also determining the source of any deterioration; and (2) to evaluate the opinions of the occupants on the houses from a sociological perspective.

The overall goal was to evaluate a wide selection of CBSW homes constructed by different organizations with a range of styles, such that the



Wall details of modern CBSW housing. Credit: Sebastian Kaminski.

impacts of these differences could be compared. All of the findings would then be collated and converted into a series of recommendations for the future design of CBSW housing around the world.

The on-site evaluations were led by Seb Kaminski, with members of the investigative team coming from Arup, Base Bahay, Build Change, National University of Costa Rica, Studio Cardenas and Babuterra.

Costa Rica: Breaking ground for low-income communities

In 1986, the Costa Rican National Bamboo Project (Proyecto Nacional de Bambú – PNB) was set up to develop and implement CBSW housing for vulnerable low-income communities across the country. The designs used in Costa Rica featured a naturally durable hardwood or treated *guadua* bamboo for the frame, with a wall matrix of *esterilla* or *caña brava* (a small-diameter cane), covered in cement mortar render, with a lightweight corrugated iron sheeting roof.

The *guadua*, *caña brava* and *esterilla* were all treated with boron. In total, up until 2000, approximately 5400 of these single-story low-cost houses were built for low-income communities across the country. This project broke major ground, and is considered to be the world's first modern engineered CBSW housing.

Colombia: Building back stronger

In 1999, a 6.2-magnitude earthquake struck the cities of Armenia, Pereira and Manizales in Colombia, along with the surrounding areas. Over 1000 people tragically died and 300,000 were made homeless. Owing to the good performance of *bahareque* traditional structures in the earthquake, a number of NGOs and international development agencies implemented reconstruction projects that primarily used bamboo for building structures following the *bahareque* style, but with modern engineering inputs and details.

This interest spurred the Colombian Earthquake Engineering Association to conduct research into CBSWs, which included a series of shear tests on wall panels. Following this, the *Construction Manual for Seismically Resistant Housing using Mortared Bahareque* (Manual de construcción sismo resistente de viviendas en bahareque encementado) was published, alongside a new chapter in the Colombian design and building code – NSR-98.

The new houses were a mixture of one- and two-story buildings, varying from detached to terraced. Wall systems adopted a variety of techniques, including braced and unbraced *guadua* and/or timber frames, and used either *esterilla* or expanded steel mesh for the matrix. Most of the bamboo was treated with boron. It is believed that over 1000 homes in total were constructed as part of these projects.

Left: Ceiling in house in Costa Rica. Right: Front of house in Colombia. Credit: Sebastian Kaminski.

Left: Bamboo rafter rotten where exposed to rain in Costa Rica. Right: Bamboo column rotten where exposed to driving rain in Colombia. Credit: Sebastian Kaminski.

Main discoveries

Generally speaking, most residents who were interviewed about their opinions of their house had a good or very good perception of bamboo houses, and this perception had improved since they moved in. This view was held even in the face of some design or construction problems. Many positive comments were linked to the occupants' belief in the good performance of bamboo houses in earthquakes. Some occupants still retained a preference for masonry or concrete houses.

The boron-treated bamboo proved to be very effective at preventing termite and beetle attack. Indoor attack was only seen in a very few places, suggesting that those areas had been inadequately treated. Given how limited these attacks were, it suggested that the original quality assurance was high. The condition of bamboo inside the buildings was generally excellent, except water ingress had occurred.

Occupants tended to view the thermal performance of the houses positively. Some complained of temperature extremes. However, the majority of respondents were content.

Water ingress and rot were the main issues observed in many houses, especially those in Colombia. Unfortunately, many of the original designs did not adequately prepare for this risk. This is particularly evident with regards to driving rain — that is, rain that is blown by strong winds — that wets the base of exterior walls, inadequate wall detailing and improper roofing design.

Significant rot was seen in all of the bamboo that was exposed to driving rain, with boron and paint proving to be ineffective protections.

Vermin were reported in many communities. The original designs of many of the houses inadvertently created areas in which vermin could breed and thrive, posing a health risk to the occupants.

Going forward

Following the investigation, a series of structural recommendations emerged for permanent affordable bamboo housing.

Permanent CBSW housing should be designed and constructed for a 50-year design life without significant expected maintenance. This is easily achievable following the recommendations provided in the *Manual for the design of bamboo structures to ISO 22156:2021*. It is not considered appropriate to expect end users of affordable housing to conduct significant structural maintenance themselves.

Dealing with potential water ingress at the base of the wall is key. Drainage of water on a macro scale in the community needs to be considered in order to carry water away from the walls of the houses. Bamboo must never be cast into concrete foundations or upstands, as it will rot. Damp-proof membranes separating all timber and bamboo framing from the foundation and structural upstand are essential. The base of the timber and bamboo frames should sit on an

elevated upstand ideally 400mm high above the external finished floor level.

Bamboo and its connections must not be fully exposed to rain and ultraviolet (UV) light, and therefore the walls need to be carefully designed to reduce this risk. Bamboo outside of the rain and UV light "shadow" (recommended as the line 30 to 45 degrees to the horizontal which extends from the roof edge towards the building) has a limited lifespan, even if treated with boron (or indeed most other chemicals). Within this line, the combination of sun and driving rain has been demonstrated to split the bamboo and cause rot. Paints and varnishes, even if applied frequently, reduce but do not solve the issue. No treatment chemical that is safe for housing has been identified worldwide that would solve the issue and provide a 50-year design life. ISO 22156:2021 explicitly forbids bamboo in permanent structures to be used in Use Class 3.2, which involves bamboo exposed to driving rain.

External rendered walls should have their exposure to driving rain minimized, in particular in two-story and taller houses. Rendering helps to reduce their permeability. Good drip details throughout are essential (above and below windows, above upstands and anywhere where water can collect). Walls should be permitted to "breathe" internally to allow them to dry out. Additionally, special protection is required for CBSW wall panels in internal areas with water risks, such as sinks and showers.

Roof design is also important to confidently prevent water ingress. Roof sheeting should be durable with at least a 25-year design life, such that replacement is not required more than once in a 50-year design life. It may be worthwhile to consider corrugated cement-fiber board sheeting, which is light (and therefore better in seismic areas), durable, has good water-resistance and has thermal performance, in addition to nearby properties to prevent water ingress. This is because runoff from one roof may affect the walls of an adjacent house.

Fire risks in affordable housing can be high. Bamboo and timber elements should not be exposed to sources of naked flames.

To ensure adequate structural and earthquake performance, wall matrices for CBSW housing must be fitted to the side of the structural frame, and not in-line. All modern CBSW testing and codes are based on fitting the matrix to the side of the structural frame. The wall matrix to cement mortar render bond should be robust. This is best achieved by opening the matrix such that the cement mortar render can wedge itself inside the gaps. Finally, cement mortar render should be of a sufficient strength and quality to be durable and have a low permeability.

In addition to these structural recommendations, several other points warrant close attention.

Prioritizing safety, it is essential to remind beneficiaries and homeowners of the risks of earthquakes and good practices during an earthquake. In addition, the thermal performance of houses is non-negotiable and can be ensured with simple design characteristics in hot areas that lack air conditioning. To reduce health risks, hidden areas should be eliminated to discourage vermin from nesting. Finally, the local community should be involved in the design process so their inputs are integrated with planning, which will naturally increase their sense of ownership.

Low-carbon, disaster-resilient and affordable, CBSW houses have a demonstrated track record of enduring use. Moreover, they have the potential to last upwards of 50 years, requiring minimal maintenance. However, like any bio-based construction system, it inevitably requires extra care in the design and workmanship of waterproofing details to prevent rot, compared to conventional systems such as reinforced concrete and masonry. Despite this, the revisited housing projects in Costa Rica and Colombia are strong evidence of the long-term sustainability of bamboo homes, and a clear indicator of their promising future.

SEBASTIAN KAMINSKI

Sebastian Kaminski is an Associate Structural Engineer at Arup. He is a specialist in the structural design of bamboo and bamboo housing, and co-author of the ISO 22156 structural design with bamboo code.

INTERNODE

Collating the latest international news and activities around bamboo and rattan sectors development

Exterior view of the Ark Gymnasium at Green School Bali, the 2022 Winner of the Supreme Award for Structural Engineering Excellence. Credit: The Institution of Structural Engineers.

Schools, airports, high-rise towers: architects urged to get 'bamboo-ready'

The Institution of Structural Engineers has urged architects and engineers to become "bamboo-ready," publishing a new manual to support the design of permanent bamboo buildings as a low-carbon alternative to steel and concrete. Titled the *Manual for the design of bamboo structures to ISO 22156:2021*, the work responds to the construction sector's significant carbon footprint, which accounts for roughly one-third of global emissions, much of it from cement use. The manual aims to address technical knowledge gaps that have limited bamboo's broader adoption, despite its historic use in construction and its growing role in high-profile projects such as Bengaluru's Kempegowda International Airport Terminal 2, the 20-meter Ninghai bamboo tower in China and the Green School in Bali (pictured above).

Advocates highlight bamboo's rapid growth cycle, structural potential and environmental benefits, including its capacity to store carbon, restore degraded soils and grow with minimal chemical inputs. Engineered bamboo has demonstrated resilience in earthquake-prone regions such as Colombia and the Philippines, supporting disaster-resistant housing built from local materials. While not suitable for taller buildings, experts argue bamboo can replace timber in many applications and serve as a scalable, climate-friendly material, particularly in tropical regions and increasingly in areas of Europe. The manual's authors hope it will encourage educators and practitioners worldwide to integrate bamboo into mainstream architectural and engineering practice.

Source: The Guardian, 22 January

NEF President urges investment, national bamboo policy to drive economic diversification

The President of the Nigeria Entrepreneurs Forum (NEF), Dr. Sidney Inegbedion, has called for the

development of a national bamboo policy to accelerate Nigeria's economic diversification and reduce dependence on oil. Speaking at a national workshop in Abuja, organized by the Federal Ministry of Budget and Economic Planning in collaboration with NEF and industry stakeholders, he described bamboo as a high-potential, underutilized resource capable of driving job creation, SME growth, import substitution, export expansion and foreign direct investment. He noted that despite Nigeria possessing one of Africa's largest bamboo reserves, the absence of a coordinated policy framework has limited investment and fragmented sectoral development.

Inegbedion highlighted the rapid growth of the global bamboo market and outlined bamboo's wide-ranging applications across construction, energy, textiles, furniture, packaging and climate solutions. He advocated for learning more about China's successful bamboo industry model through technical and financial cooperation, including support under the Forum on China-Africa Cooperation. Government representatives and sector stakeholders expressed support for the proposed policy. The workshop closed by inaugurating a Technical Working Group tasked with developing a National Bamboo Policy to promote green growth and economic development.

Source: The Authority, 10 February

Scientists are rethinking bamboo as a powerful new superfood

A new academic review from researchers at Anglia Ruskin University suggests bamboo shoots may have significant potential as a "superfood," citing evidence of benefits for blood sugar regulation, inflammation reduction, gut health and antioxidant activity. The study, the first comprehensive review of bamboo as a food source, analyzed existing human and laboratory research and found that bamboo shoots are rich in protein, fiber, essential amino acids, vitamins and minerals while being low in fat. Human trials indicated improved glycemic control and healthier lipid profiles, pointing to possible advantages for managing diabetes and reducing cardiovascular risk, while laboratory studies suggested probiotic and cell-protective effects.

The review also highlighted bamboo's potential role in food safety, as certain compounds may reduce the formation of toxic substances such as furan and acrylamide during cooking. However, researchers cautioned that some bamboo species contain cyanogenic glycosides and other compounds that may interfere with thyroid function if not properly prepared. These risks can be mitigated through adequate pre-boiling. While the findings position bamboo as a promising, sustainable addition to global diets, the authors emphasized that more high-quality human trials are needed before concrete dietary recommendations can be made.

Source: Science News, 16 January

"Unzipping" bamboo to make better plastics

Researchers at Northeast Forestry University in China have developed a high-performance, recyclable bioplastic made from bamboo cellulose that could potentially serve as a sustainable alternative to petroleum-based plastics. Using a low-energy chemical process, the team separated and reorganized cellulose fibers with a "molecular zipper" system. This method avoided the high temperatures and harsh conditions typical of industrial plastic production, resulting in a reinforced 3D cellulose network that was later solidified into a dense, rigid bioplastic.

Testing showed the material to be significantly stronger and more durable than conventional plastics, with significantly improved resistance to stretching, bending, temperature extremes, humidity, acids and solvents. It remained stable in conditions ranging from -30°C to over 250°C and maintained structural integrity after prolonged exposure to the environment. The bioplastic can be molded with standard manufacturing techniques, and both production scraps and solvents can be recycled without performance loss. When buried in soil, the material fully decomposed within 50 days, highlighting its potential as a scalable, environmentally friendly replacement for traditional plastics.

Source: Sciworthy, 2 February

INBAR SPOTLIGHT

INBAR commissions research, conducts project work and raises awareness about bamboo and rattan across its 52 Member States.

Fieldwork undertaken in Northeastern Peru to map the spatial distribution of bamboo.

Funding surge for micro-projects near Cameroon's Waza, Bénoué and Kimbi-Fungom National Parks

Thirty eco-entrepreneurs have been selected in Cameroon under the ACREGIR project, implemented by the Central Africa Regional Office (CARO) of the International Bamboo and Rattan Organization (INBAR). The 30 green micro-projects will be carried out across Waza, Bénoué and Kimbi Fungom National Parks as part of efforts to strengthen community resilience to climate change through youth entrepreneurship and the sustainable management of natural resources. The initiative concludes a broader process that pre-selected 45 candidates, each of whom presented business plans before a selection panel.

Between 2023 and 2025, around 2300 eco-entrepreneurs in Cameroon, half of whom were women and forty-percent youth, benefited from training in business development, leadership, legal frameworks and sustainable resource utilization. To ensure fairness and transparency, selection panels were chaired by Regional Delegates of the Minister of Environment, Protection of Nature and Sustainable Development of Cameroon. Candidates also participated in refresher workshops on business plan preparation and evaluation criteria, including crucial topics like environmental impact, financial viability, community involvement and administrative compliance.

The selected projects demonstrate strong potential in a wide range of areas such as food security, renewable energy, forest landscape

restoration, anti-poaching and women's empowerment. In 2026, INBAR will allocate USD 80,000 in total funding disbursed via a microfinance institution. Beneficiaries will continue to receive business coaching to ensure effective implementation, reinforcing INBAR's support to the Government of Cameroon in developing sustainable bamboo and non-timber forest product value chains.

Study identifies bamboo in Peru's Northeastern Corridor

A new technical study combining satellite imagery and fieldwork has mapped 6434 hectares of *Guadua aff. angustifolia* across Peru's northeastern corridor, covering the regions of Piura, Cajamarca and Amazonas. The findings point to significant untapped potential for sustainable development, rural employment and climate adaptation in northern Peru.

The research was carried out under INBAR's Bamboo in Northeast Peru Project, in partnership with the Peru-Ecuador Binational Border Region Development Plan and Peru's National Forest and Wildlife Service. Specialists from the Universidad Nacional Agraria La Molina led the technical work, using Sentinel-2 and Landsat-8 satellite imagery from 2024, topographic data and vegetation indices. These inputs were processed through a Random Forest classification algorithm in Google Earth Engine, producing detailed cartography of bamboo distribution.

The results far exceed existing official records. Peru's National Forest and Wildlife Information System currently lists around 2187 hectares of registered bamboo plantations nationwide, which means that the new study found nearly three times that coverage in the northeast alone. In the region, bamboo directly supports more than 5000 families involved in productive, artisanal and construction activities.

Researchers stress that the data will support evidence-based policy and help direct conservation and investment efforts. The methodology is also designed to be replicable across other regions as part of future inventories.

Young Italians boost bamboo in Ecuador

The Universal Civil Service (SCU) is an Italian government program that sends young people aged 18 to 29 abroad for up to a year to work on solidarity, cooperation and sustainable development. Through a partnership between the NGO Gondwana and INBAR, SCU volunteers have been deployed to Ecuador since 2023 to support bamboo-based development projects in the Amazon region.

INBAR has been working in Ecuador's Napo Province since 2020, running initiatives focused on bamboo value chain development and community restoration in partnership with Kichwa Indigenous communities. The first two volunteers, Alexandra and Quetzal, supported community nurseries and technical training in the field. In 2024, Pietro and Leonardo joined, contributing to project monitoring, database management and recording ancestral bamboo knowledge. They also helped organize the V Latin American and Caribbean Bamboo Symposium and co-created an illustrated children's book, *La voz de la guadua*, introducing bamboo's cultural significance to the younger generation.

By 2025, four more volunteers, Alexandra, Martina, Matilde and Serena, had joined, divided between INBAR's offices in Quito and Tena. In Quito, they support institutional coordination and project development. In Tena, they work directly with rural and Indigenous communities on bamboo silviculture and productive capacity, including close collaboration with AMUKINA, the Kichwa Women's Association of the Amazon.

The partnership benefits both parties. Volunteers gain firsthand exposure to sustainable land use, Indigenous knowledge systems and cross-cultural collaboration. Communities and INBAR teams gain fresh perspectives and additional manpower. In a region where bamboo drives environmental restoration and rural livelihoods, this alliance between Italian civil society and an international organization offers a practical model for meaningful, ground-level cooperation.

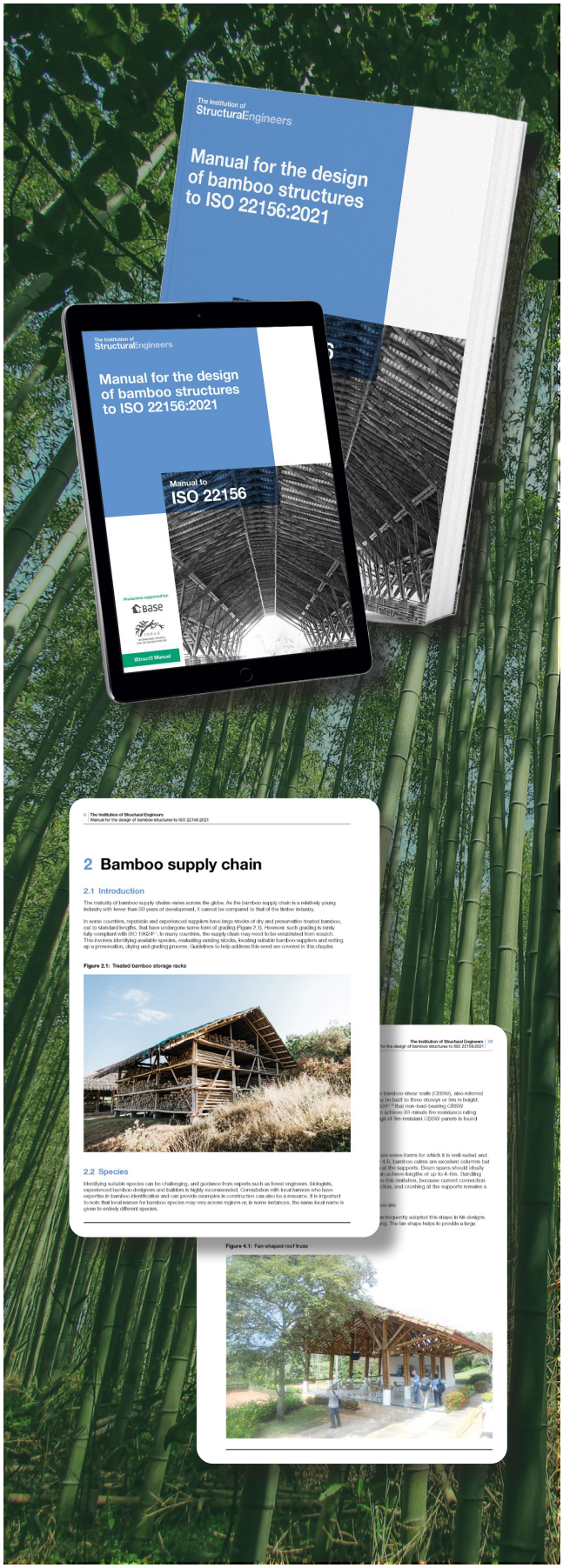
IN REVIEW

Manual for the design of bamboo structures to ISO 22156:2021

The Institution of Structural Engineers has recently published a comprehensive design manual for permanent bamboo structures aimed to promote shifting bamboo from a niche material to a mainstream construction alternative. Four international specialists contributed to the guide, all of whom are members of the INBAR Bamboo Construction Task Force. The manual aligns with the ISO 22156:2021 standard, intended to be a useful reference point for structural engineers and construction professionals. It covers ten main topics, including supply chain, project management, seismic and wind design, durability and real-world examples.

Bamboo is native to every continent except Antarctica and Europe, though many species are even able to be grown successfully across Europe. Like trees, bamboo stores carbon in its leaves, stems, roots and soil. Harvesting it does not disturb that stored carbon, making it an attractive material in the context of achieving climate goals. The construction industry is responsible for roughly 40% of global carbon emissions, and the manual's authors argue that bamboo offers a practical, renewable path toward reducing that figure.

One of the guide's stated aims is to address a longstanding imbalance in how building standards are developed. Structural codes are typically written in wealthier countries to meet their own needs, with lower- and middle-income countries adapting them later, but never from a starting point that reflects their own unique conditions and obstacles. The manual seeks to provide a more universally grounded starting point for structural codes.



The Institution of Structural Engineers. (2025) *Manual for the design of bamboo structures to ISO 22156:2021*. London, United Kingdom.

CAPTURING THE GLOBAL IMPACT OF BAMBOO AND RATTAN THROUGH LENSES AROUND THE WORLD

The final selections of the INBAR Photo Competition reveal the diverse ways bamboo and rattan are used across cultures and landscapes worldwide.

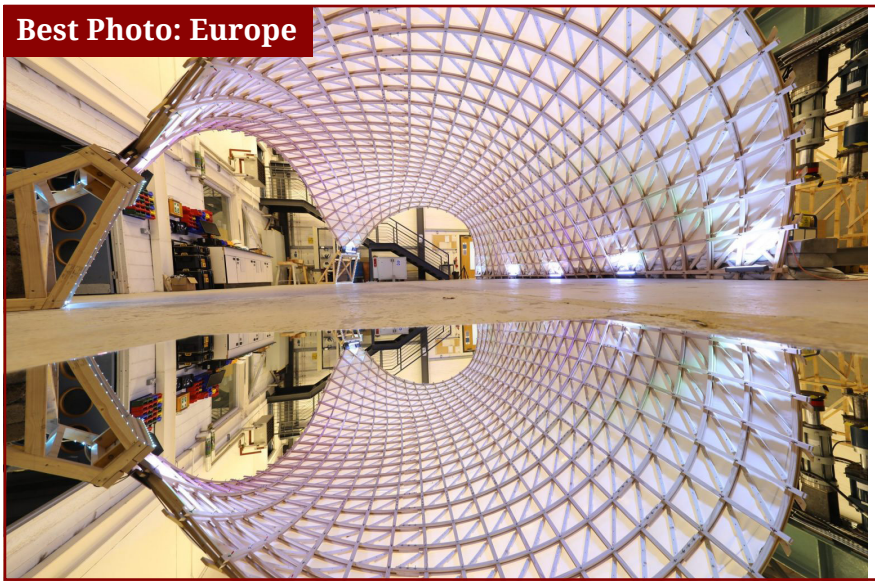
INBAR is pleased to announce the winners of the 2025 International Bamboo and Rattan Photo Competition, held under the theme "Celebrating the Global Presence of Bamboo and Rattan." This year's competition invited photographers from around the world to capture how these remarkable materials support sustainable livelihoods, protect ecosystems and inspire innovation across Africa, Asia, Europe and North America, and Latin America and the Caribbean.

A panel of professional photographers and INBAR experts reviewed submissions from around the world to select the Best Photo Awards. New for 2025, the competition also introduced a People's Choice Award, allowing the public to vote for their favorite panel-selected images through social media.

These winning photographs tell a powerful story, one that moves from forests and rivers to classrooms, across bridges, markets and into homes. Across these different regions, they reveal how bamboo and rattan support ecosystems, livelihoods, culture, education and innovation, while shaping everyday life in sustainable ways.

INBAR warmly thanks all photographers who took part in the 2025 competition for sharing their perspectives and helping bring these stories to light. Through your lenses, bamboo and rattan are shown not only as materials, but as living connections between people and nature. Selected works will be featured and credited across INBAR's platforms, where we will continue to share the stories behind the images. Congratulations to the winners!

Best Photo: Europe



"Europe's First Bamboo-Timber Composite Gridshell at Edinburgh Napier University" by Professor Hexin (Johnson) Zhang from China

Europe's first bamboo-timber composite gridshell was built at Edinburgh Napier University in four days. Woven from bamboo and softwood, the structure draws its strength from both natural materials and thoughtful design, blending traditional craftsmanship with modern digital tools.

Best Photo: Africa

"Bamboo eco-environment study" by Stephen Barasa from Kenya

This photo was taken inside a bamboo plantation while observing how bamboo supports healthy ecosystems. Bamboo absorbs large amounts of carbon, releases more oxygen than many trees, protects soil and water, and provides habitat for wildlife. Strong yet flexible, it is a climate-resilient plant that supports both nature and people, offering sustainable alternatives to timber and plastics while creating green livelihoods for communities.

People's Choice: Africa

"The love for bamboo" by Fitsum Abera from Ethiopia

This photo was taken at an artisan market, where the energy of the space reflects the life and care behind our work. The crafts represent years of collaboration, trust and learning. For them, bamboo is more than a livelihood; it is their heritage, their passion and a promise of a sustainable future.

Best Photo: Asia

"Keepers of the bamboo tradition" by Reu Dawner Flores from the Philippines

Under the soft glow of a single lantern, fishermen move quietly through the water, guiding large conical traps hand-woven from bamboo. The scene captures a living tradition passed down through generations, where skill and patience meet nature's rhythms.

People's Choice: Asia

"Bamboo bridge" by Nay Myo Hlaing from Myanmar

In this photograph, novice monks carefully cross a narrow bridge made entirely of bamboo. Each step reflects balance and quiet focus, as the simple yet resilient structure connects daily life with nature. Built from locally sourced bamboo, the bridge embodies tradition, resourcefulness and sustainability.

Best Photo: Latin America & Caribbean

"Dance in the bamboo forest" by Juan Salazar from Ecuador

This photograph captures a dance inspired by a song dedicated to *Guadua angustifolia*, the bamboo species most vital to producers in Ecuador. Moving within the bamboo forest, the dancer becomes part of the landscape, expressing respect, gratitude and cultural connection to a plant that sustains livelihoods and traditions.

People's Choice: Latin America & Caribbean

"Conexión" by Antonio Flores Calvario from Mexico

This photograph captures an intimate, grounded connection between people and bamboo. Bare feet rest on a bamboo floor, revealing how deeply this natural material is woven into everyday life. The image speaks of connection, where human and bamboo come together through tradition and sustainability.

EVENTS

3 February 2026

Trainer of Trainers | Bamboo in Northeast Peru Project
Peru

17 February 2026

Global Tourism Resilience Day

23 - 27 February 2026
Tour through the Coffee Region: Experiencing Sustainable Architecture
Colombia

3 March 2026

World Wildlife Day

8 March 2026

International Women's Day

10 March 2026

International Seminar "Bamboo as a Driver of Green Development and Climate Resilience"
Argentina

21 March 2026

International Day of Forests

22 March 2026

World Water Day

24 - 25 March 2026
Webinar Series: "Bamboo Biochar: Science, Innovation, and Applications in the Americas"
Online

26 - 28 March 2026

Seventh Global Meeting of the Mountain Partnership

Andorra

For more information, please see INBAR's event page:

https://www.inbar.int/events/.

On World Wildlife Day, we celebrate the biodiversity that sustains our planet and the remarkable conservation success of wild mountain gorillas in Volcanoes National Park, Rwanda. Credit: UNEP

A candidate defending his micro-project on bamboo for Kimbi Fungom National Park.

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INTERNATIONAL BAMBOO
AND RATTAN ORGANIZATION

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